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Applicant: Makoto Funabiki, et al. : Art Unit:
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FOR: MOBILE COMMUNICATION METHOD, MOBILE COMMUNICATION APPARATUS, HOME AGENT APPARATUS, ACCSESS ROUTER INFORMATION SERVER APPARATURS, AND MOBILE COMMUNICATION SYSTEM

VERIFICATION OF A TRANSLATION

Assistant Commissioner for Patents
Washington, D.C. 20231
SIR :

I, the below named translator, hereby declare that:

1. My name and post office address are as stated below.

2. That I am knowledgeable in the English language and in the language of JP2003-374186, and I believe the attached English translation to be a true and complete translation of JP2003-374186.

3. The document for which the attached English translation is being submitted is a patent application on an invention entitled MOBILE COMMUNICATION METHOD, MOBILE COMMUNICATION APPARATUS, HOME AGENT APPARATUS, ACCSESS ROUTER INFORMATION SERVER APPARATURS, AND MOBILE COMMUNICATION SYSTEM.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: August 17, 2009

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[Name of the Document] Claims

[Claim 1]

A mobile communication method comprising:

a step in which a mobile communication apparatus determines whether a pre-movement source access router apparatus connected therewith complies with Fast Mobile IP or not,

a step in which the mobile communication apparatus during its movement detects a signal from a movement-destination access router apparatus, and

a step in which in the case where the mobile communication apparatus has determined that the pre-movement source access router apparatus does not comply with Fast Mobile IP when detecting the communication, the mobile communication apparatus requests a home agent apparatus for information on the movement-destination access router apparatus, and the home agent apparatus responds to the request, providing information on the movement-destination access router apparatus to the mobile communication apparatus, and the mobile communication apparatus instructs the home agent apparatus to forward data addressed to the mobile communication apparatus to the movement-destination access router apparatus.

[Claim 2]

The mobile communication method according to claim 1, wherein the home agent apparatus stores information on access router apparatuses, and searches and gives information on the movement-destination access router apparatus in accordance with a request by the mobile communication

apparatus.

[Claim 3]

The mobile communication method according to claim 1, wherein the home agent apparatus makes inquiries about information on the movement-destination access router apparatus to an access router information server apparatus storing information on access router apparatuses, in accordance with the request by the mobile communication apparatus, and gives the information to the mobile communication apparatus.

[Claim 4]

The mobile communication method according to any one of claims 1 to 3, wherein the mobile communication apparatus notifies the home agent apparatus of an identifier tag of the movement-destination access router apparatus, and the home agent apparatus searches or inquires about information on the movement-destination access router apparatus based on the identifier tag.

[Claim 5]

The mobile communication method according to claim 4, wherein the identifier tag of the movement-destination access router apparatus is either a lower layer address or a cell station ID.

[Claim 6]

The mobile communication method according to any one of claims 1 to 4, further comprising a step in which when the home agent apparatus could not acquire information on the movement-destination access router apparatus, the home agent apparatus notices the mobile communication

apparatus accordingly.

[Claim 7]

A mobile communication method comprising:

a step in which a mobile communication apparatus determines whether a pre-movement source access router apparatus connected therewith complies with Fast Mobile IP or not,

a step in which the mobile communication apparatus during its movement detects a signal from a movement-destination access router apparatus, and

a step in which in the case where the mobile communication apparatus has determined that the pre-movement source access router apparatus does not comply with Fast Mobile IP when detecting the communication, the mobile communication apparatus acquires information about the movement-destination access router apparatus from an access router information server apparatus storing the information about an access router apparatus, and instructs a home agent apparatus to forward data addressed to the mobile communication apparatus to the movement-destination access router apparatus.

[Claim 8]

The mobile communication method according to claim 1, further comprising:

a step in which when the mobile communication apparatus has determined that the pre-movement source access router apparatus does not comply with Fast Mobile IP, and that the movement-destination access router apparatus complies with Fast Mobile IP, the mobile communication

apparatus instructs the home agent apparatus to forward data addressed to the mobile communication apparatus to the movement-destination access router apparatus, a step in which the home agent apparatus establishes a tunnel between the home agent apparatus and the movement-destination access router apparatus, and notifies the establishment thereof to the mobile communication apparatus, and a step in which the movement-destination access router apparatus forwards the data addressed to the mobile communication apparatus received via the tunnel to the mobile communication apparatus.

[Claim 9]

The mobile communication method according to claim 8, further comprising:

a step in which when the mobile communication apparatus has determined that the pre-movement source access router apparatus complies with Fast Mobile IP, and that the movement-destination access router apparatus does not comply with Fast Mobile IP, the mobile communication apparatus instructs the pre-movement source access router apparatus to forward data addressed to the mobile communication apparatus to the home agent apparatus,

a step in which the pre-movement source access router apparatus establishes a tunnel between the pre-movement source access router apparatus and the home agent apparatus, and notifies the establishment thereof to the mobile communication apparatus, and

a step in which the home agent apparatus forwards the data addressed to the mobile communication apparatus received via the tunnel to

the mobile communication apparatus.

[Claim 10]

The mobile communication method according to claim 9, wherein the instruction given by the mobile communication apparatus with respect to the pre-movement source access router apparatus is one in which the address of the home agent apparatus is written in the new care-of address field of a fast binding update message according to a Fast Mobile IP procedure.

[Claim 11]

The mobile communication method according to claim 9 or 10, further comprising:

a step in which the home agent apparatus starts buffering in the case that buffering is possible when the home agent apparatus receives an instruction from the pre-movement source access router apparatus for buffering transmission data addressed to the mobile communication apparatus.

[Claim 12]

The mobile communication method according to claim 11, further comprising:

a step in which the home agent apparatus notifies the start of the buffering to the pre-movement source access router apparatus.

[Claim 13]

The mobile communication method according to claim 12, wherein in the case that the buffering is impossible, the home agent apparatus notifies the pre-movement source access router apparatus that buffering cannot be executed.

[Claim 14]

A mobile communication system comprising a network having plural sub-networks, access router apparatuses connected to the sub-networks, a mobile communication apparatus making packet-communications with the network through the access router apparatuses, a home agent apparatus connected to the network which implements mobile management of the mobile communication apparatus moving between sub-networks, and at least one correspondent node connecting to the network, which makes communication with the mobile communication apparatus, in which the access router apparatuses which comply with Fast Mobile IP are intermixed with those which do not comply with it, and the mobile communication apparatus, after moving to a different sub-network, makes a local registration to the home agent apparatus to continue the communication with the correspondent node,

wherein the mobile communication apparatus has a function of determining whether the access router apparatus complies with Fast Mobile IP or not, and if it determines that the pre-movement source access router apparatus complies with Fast Mobile IP, the mobile communication apparatus acquires information on the movement-destination access router apparatus from the pre-movement source access router apparatus to implement a Fast Mobile IP procedure, and if the mobile communication apparatus determines that the pre-movement source access router apparatus does not comply with Fast Mobile IP, the mobile communication apparatus requests the home agent apparatus for information on the movement-destination access router apparatus,

the home agent apparatus provides the information on the movement-destination access router apparatus to the mobile communication apparatus in response to the request, and

the mobile communication apparatus instructs the home agent apparatus to forward data addressed to the mobile communication apparatus to the movement-destination access router apparatus.

[Claim 15]

A mobile communication system comprising a network having plural sub-networks, access router apparatuses connected to the sub-networks, a mobile communication apparatus making packet-communications with the network through the access router apparatuses, a home agent apparatus connected to the network which implements mobile management of the mobile communication apparatus moving between sub-networks, at least one correspondent node connecting to the network, which makes communication with the mobile communication apparatus, and an access router information server apparatus storing information on the access router apparatuses, in which the access router apparatuses which comply with Fast Mobile IP are intermixed with those which do not comply with it, and the mobile communication apparatus, after moving to a different sub-network, makes a local registration to the home agent apparatus to continue the communication with the correspondent node, wherein the mobile communication apparatus has a function of determining whether the access router apparatus complies with Fast Mobile IP or not, and if it determines that the pre-movement source access router apparatus complies with Fast Mobile IP, the mobile communication apparatus acquires information on the

movement-destination access router apparatus from the pre-movement source access router apparatus to implement a Fast Mobile IP procedure, and if the mobile communication apparatus determines that the pre-movement source access router apparatus does not comply with Fast Mobile IP, the mobile communication apparatus acquires information on the movement-destination access router apparatus from the access router information server apparatus, and instructs the home agent apparatus to forward data addressed to the mobile communication apparatus to the movement-destination access router apparatus.

[Claim 16]

A mobile communication apparatus comprising a mobile IP/Fast Mobile IP processing part for implementing standard Mobile IP processing and Fast Mobile IP processing, an access router searching part for acquiring information on access router apparatuses from the mobile IP/Fast Mobile IP processing part, a Fast Mobile IP compliance determining part for determining whether an access router apparatus complies with Fast Mobile IP based on the information acquired at the access router searching part, and a Fast Mobile IP control part for controlling the contents of a message generated by the mobile IP/Fast Mobile IP processing part based on the result of operation of the Fast Mobile IP compliance determining part.

[Claim 17]

The mobile communication apparatus according to claim 16, wherein the information on the access router apparatuses is acquired from a home agent apparatus which manages movements of the mobile communication apparatus between sub-networks or from an access router apparatus.

[Claim 18]

The mobile communication apparatus according to claim 16 or 17, wherein if the Fast Mobile IP compliance determining part determines that the pre-movement source access router apparatus does not comply with Fast Mobile IP, the Fast Mobile IP control part gives identifying information of the movement-destination access router apparatus to the home agent apparatus or an access router information server apparatus, and controls the mobile IP/Fast Mobile IP processing part so as to request information on the movement-destination access router apparatus.

[Claim 19]

The mobile communication apparatus according to any one of claims 16 to 18, wherein when the Fast Mobile IP compliance determining part determines that the movement-destination access router apparatus complies with Fast Mobile IP, based on the information on the movement-destination access router apparatus obtained from the home agent apparatus, the Fast Mobile IP control part controls the Mobile IP/Fast Mobile IP processing part so that the home agent apparatus forwards data addressed to the mobile communication apparatus to the movement-destination access router apparatus.

[Claim 20]

The mobile communication apparatus according to any one of claims 16 to 18, wherein when the Fast Mobile IP compliance determining part determines that the pre-movement source access router apparatus complies with Fast Mobile IP, and that the movement-destination access router apparatus does not comply with Fast Mobile IP, the Fast Mobile IP control

part controls the Mobile IP/Fast Mobile IP processing part so that the movement-destination access router apparatus forwards data addressed to the mobile communication apparatus to the home agent apparatus.

[Claim 21]

The mobile communication apparatus according to claim 16, wherein the Mobile IP/Fast Mobile IP processing part sends a message in which an address of the home agent apparatus is written in the new care-of address field of a fast binding update message according to a Fast Mobile IP procedure to the pre-movement source access router apparatus.

[Claim 22]

A home agent apparatus comprising a mobile IP/Fast Mobile IP processing part for implementing standard mobile IP processing and fast Mobile IP processing, a buffer memory for temporarily storing data addressed to the mobile communication apparatus of a management target, and a buffer management part for managing input and output to and from the buffer memory when receiving a request for storing of the data to be sent to the mobile communication apparatus which is received by the mobile IP/Fast Mobile IP processing part or a request for transmission of the stored data.

[Claim 23]

The home agent apparatus according to claim 22, wherein the buffer management part starts to buffer data when it receives a message requesting start of buffering from the pre-movement source access router apparatus, and transmits the buffered data to the mobile communication apparatus to which the data is addressed when the buffer management part

receives a message requesting start of transmission of the buffered data from the movement-destination access router apparatus.

[Claim 24]

The home agent apparatus according to claim 22 or 23, further comprising a movement-destination access router searching part for requesting the access router information server apparatus which stores information on access router apparatuses for information on the movement-destination access router apparatus in response to the inquiry of information on the movement-destination access router apparatus, and giving the acquired information to the requesting apparatus.

[Claim 25]

The home agent apparatus according to claim 24, wherein the movement-destination access router searching part makes a request to the access router information server apparatus based on an identifier flag of the movement-destination access router apparatus acquired when the movement-destination access router searching part receives the request from the mobile communication apparatus.

[Claim 26]

The home agent apparatus according to claim 24 or 25, further comprising an access router information list in which identifier tags of access router apparatuses, IP addresses of the access router apparatuses, and compliance and/or noncompliance with Fast Mobile IP of the access router apparatuses are written, and an access router information searching part for searching for entries corresponding to the identifier tag included in the received message requesting information on an access router apparatus,

wherein the movement-destination access router searching part instructs the access router information searching part to search for information on the movement-destination access router apparatus in response to the request.

[Claim 27]

The home agent apparatus according to claim 24 or 25, wherein the identifier tag of the access router apparatus is at least either a lower layer address or a cell station ID.

[Claim 28]

An access router information server apparatus comprising an access router information list in which identifier tags of access router apparatuses, IP addresses of the access router apparatuses, and compliance and/or noncompliance with Fast Mobile IP of the access router apparatuses are written, a receiving part for receiving requests for information on the access router apparatuses from various kinds of apparatuses on the network, an access router information searching part for searching the access router information list for entries corresponding to the identifier tag included in the received request, and an access router information notifying part for notifying the search result to the requesting apparatus.

[Claim 29]

The access router information server apparatus according to claim 28, wherein the identifier tag of the access router apparatus is either a lower layer address or a cell station ID.

[Name of the Document] Specification

[Title of the Invention] Mobile communication method, mobile communication apparatus, home agent apparatus, access router information server apparatus, and mobile communication system

[Field of the Invention]

[0001]

The present invention relates to a mobile communication method, a mobile communication apparatus, a home agent apparatus, an access router information server apparatus, and a mobile communication system, using a mobile IP.

[Background Art]

[0002]

A mobile communication system using a mobile IP includes a mobile communication apparatus performing communications while moving between sub-networks, a home agent apparatus performing location management of the mobile communication apparatus, a correspondent node connected to the Internet which communicates with the mobile communication apparatus, and access router apparatuses to which the mobile communication apparatus connects in order to communicate with the correspondent node connected to the Internet. In this configuration, one mobile communication method using the conventional mobile IP is described in non-patent document 1.

[0003]

First, the mobile communication apparatus, when the Internet mobile communication apparatus moves to a different sub-network, receives

a router advertisement message from the access router apparatus which belongs to the movement-destination sub-network, and generates from prefix information included in the message a care-of address which is temporarily used in the sub-network. After that, the mobile communication apparatus sends a binding update message including its home address (hereinafter called binding update) and newly generated care-of address to the home agent apparatus. The home agent apparatus receives the binding update message and adds the home address and the care-of address pair included in the received binding update message to a binding cache in which home address and the corresponding care-of address pairs are stored. Then, transmitted packets addressed to the home address of the mobile communication apparatus are intercepted by the home agent apparatus and forwarded to the current care-of address of the mobile communication apparatus.

[0004]

In the conventional mobile communication method, during a period of time from the movement of the mobile communication apparatus to the different sub-network until it registers the care-of address which has been acquired at the movement-destination sub-network in the home agent apparatus, arriving packets addressed to the home address of the mobile communication apparatus are forwarded to the previous care-of address of the mobile communication apparatus from the home agent apparatus, and therefore packet loss occurs.

[0005]

As a method for reducing the packet loss, there is a method of

forwarding and buffering packets between access router apparatus (hereinafter referred to as a "Fast Mobile IP") described in non-patent document 2. Fig. 34 is a sequence diagram showing operations of the Fast Mobile IP.

[0006]

In a procedure of the Fast Mobile IP, when the mobile communication apparatus detects a new access router apparatus (step S3401), it sends a message including a lower layer address of the movement-destination access router apparatus to the pre-movement source access router apparatus (step S3402), and acquires the IP address of the movement-destination access router apparatus (step S3403). The mobile communication apparatus, after acquiring the IP address, sends to the pre-movement source access router apparatus a message requesting the transmitted packets addressed to the care-of address of the mobile communication apparatus be forwarded to the movement-destination access router apparatus (step S3404). After that, the pre-movement source access router apparatus establishes a tunnel between it and the movement-destination access router apparatus, and instructs the movement-destination access router apparatus to buffer the packet temporarily (steps S3405, S3406). After that, the pre-movement source access router apparatus sends a verification message indicating that the establishment of the tunnel is completed to the mobile communication apparatus (step S3407). After receiving the verification message, the mobile communication apparatus performs a handover processing in the lower layer (step S3409). After the handover is finished in the lower layer, the mobile communication apparatus sends a message indicating that the

start of forwarding in the buffered packets to the movement-destination access router apparatus (step S3410). When the movement-destination access router apparatus receives the message, it transmits the buffered packets to the mobile communication apparatus (step S3414). The mobile communication apparatus acquires the new sub-network prefix from the router advertisement message (step S3411) sent by the movement-destination access router apparatus and generates a new care-of address (step S3421), then, updates the binding caches of the home agent apparatus, the contacted correspondent node, and so on (steps S3412, S3413, S3415). These processes are standard mobile IP processes described in non-patent document 1 (hereinafter referred to as "standard mobile IP").

[0007]

As a method for preventing the occurrence of packet loss in the case that the access router apparatuses of the pre-movement source sub-network and the movement-destination sub-network do not comply with the Fast Mobile IP, there is the method described in patent document 1.

[0008]

In this mobile communication method, when it becomes clear that the mobile communication apparatus is in the period when it cannot be contacted, the apparatus sends a telegraphic message informing that the non-contact period has started to the home agent apparatus, and the home agent apparatus which has received the telegraphic message that the non-contact period has started stores the data packets addressed to the mobile communication apparatus received by the home agent apparatus from that time. When the non-contact period has finished, the mobile

communication apparatus sends a telegraphic message that the non-contact period has ended to the home agent apparatus, and the home agent apparatus receives the message and forwards the previously stored data packets addressed to the mobile communication apparatus. Then, the mobile communication apparatus receives and processes the data packets forwarded from the home agent apparatus.

[0009]

Furthermore, as a conventional mobile communication system for reducing packet loss in the mobile IP, there is the system described in patent document 2. This is the method that a gateway apparatus installed at the home agent apparatus or between the home agent apparatus and the access router apparatus buffers or bicasts packets addressed to the mobile communication apparatus. In this method, the mobile communication apparatus sends a registration message for performing a double registration of the movement-destination foreign agent apparatus and the pre-movement source foreign agent apparatus in the home agent apparatus and the gateway apparatus. According to the double registration, the home agent apparatus transmits the same packet to the movement-destination foreign agent apparatus and to the pre-movement source foreign agent apparatus (bicasts). The home agent apparatus, after receiving the registration message, judges whether the packet has been received in real-time, and if it is real-time traffic, performs bicasting to the pre-movement source foreign agent apparatus and to the movement-destination foreign agent apparatus, otherwise, performs buffering.

Patent document 1: Unexamined Japanese Patent Application Publication No. 2003-209890 (pages 6-9, Fig. 7)

Patent document 2: Unexamined Japanese Patent Application Publication No. 2002-125254 (pages 6-12, Fig. 1)

Non-patent document 1: "Mobility Support in IPv6", IETF Mobile IP WG Internet draft < URL: HYPERLINK

http:///www.ietf.org/internet-drafts/draft-ietf-mobileip-ipv6-24.txt

http:///www.watersprings.org/pub/id/draft-ietf-mobileip-ipv6-24.txt>

Non-patent document 2: "Fast Handovers for Mobile IPv6", IETF Mobile IP WG Internet draft < URL: HYPERLINK

http:///www.watersprings.org/pub/id/draft-ietf-mobileip-fast-mipv6-08.txt

http:///www.watersprings.org/pub/id/draft-ietf-mobileip-fast-mipv6-08.txt>

[Disclosure of the Invention]

[Problems to be Solved by the Invention]

[0010]

However, in the conventional mobile communication method described in non-patent document 2, the tunnel has to be established by exchanging messages between the pre-movement source access router apparatus and the movement-destination access router apparatus, and it is therefore required that the both access router apparatuses comply with the Fast Mobile IP. Specifically, when instructing the access router apparatus which does not comply with the Fast Mobile IP to establish the tunnel, the instruction is ignored and packets are lost.

[0011]

On the other hand, in the conventional mobile communication method described in patent document 1, even when both access router apparatuses of the pre-movement source and the movement-destination comply with the Fast Mobile IP, a tunnel cannot be established, and as a result inefficient forwarding is performed.

[0012]

In actual networks, since all the access router apparatuses do not necessarily comply with the Fast Mobile IP, there is a problem that the Fast Mobile IP cannot be applied.

[0013]

Furthermore, in the configuration of patent document 2, since it is necessary that processes such as buffering and bicasting are performed frequently, there is a problem that the load of the home agent apparatus becomes high.

[0014]

An object of the present invention is to solve these problems by providing a mobile communication method allowing Fast Mobile IP to be applied without greatly increasing the load of the home agent apparatus even when the access router apparatus does not comply with Fast Mobile IP.

[0015]

Particularly, it provides a mobile communication method and a mobile communication system which effectively carries out the procedure of Fast Mobile IP in which the mobile communication apparatus determines the start of a handover.

[Means to Solve the Problems]

[0016]

To solve the problems, the mobile communication method of the present invention is a mobile communication method including a step in which a mobile communication apparatus determines whether a pre-movement source access router apparatus connected therewith complies with Fast Mobile IP or not, a step in which the mobile communication apparatus during its movement detects a signal from a movement-destination access router apparatus, and a step in which in the case where the mobile communication apparatus has determined that the pre-movement source access router apparatus does not comply with Fast Mobile IP when detecting the communication, the mobile communication apparatus requests a home agent apparatus for information on the movement-destination access router apparatus, and the home agent apparatus responds to the request, providing information on the movement-destination access router apparatus to the mobile communication apparatus, and the mobile communication apparatus instructs the home agent apparatus to forward data addressed to the mobile communication apparatus to the movement-destination access router apparatus. In this way, the mobile communication apparatus can implement the Fast Mobile IP procedure even when the pre-movement source access router apparatus does not comply with the Fast Mobile IP, thereby reducing packet loss.

[0017]

Alternatively, in the mobile communication method of the present invention, the home agent apparatus stores information on access router

apparatuses, and searches and gives information on the movement-destination access router apparatus in accordance with a request by the mobile communication apparatus. In this way, the mobile communication apparatus can acquire information on the movement-destination access router apparatus from the home agent apparatus.

[0018]

Alternatively, in the mobile communication method of the present invention, the home agent apparatus makes inquiries about information on the movement-destination access router apparatus to an access router information server apparatus storing information on access router apparatuses, in accordance with the request by the mobile communication apparatus, and gives the information to the mobile communication apparatus. In this way, it becomes unnecessary for the home agent apparatus to store information on the access routers.

[0019]

Alternatively, in the mobile communication method of the present invention, the mobile communication apparatus notifies the home agent apparatus of an identifier tag of the movement-destination access router apparatus, and the home agent apparatus searches or inquires about information on the movement-destination access router apparatus based on the identifier tag. In this way, the home agent apparatus can search for information on the movement-destination access router efficiently.

[0020]

Alternatively, in the mobile communication method of the present

invention, the identifier tag of the movement-destination access router is either a lower layer address or a cell station ID. In this way, the movement-destination access router can be uniquely identified.

[0021]

Alternatively, the mobile communication method of the present invention further includes a step in which when the home agent apparatus could not acquire information on the movement-destination access router apparatus, the home agent apparatus notices the mobile communication apparatus accordingly. In this way, the mobile communication apparatus can know that information on the movement-destination access router could not be applied.

[0022]

Alternatively, the mobile communication method of the present invention is a mobile communication method including a step in which a mobile communication apparatus determines whether a pre-movement source access router apparatus connected therewith complies with Fast Mobile IP or not, a step in which the mobile communication apparatus during its movement detects a signal from a movement-destination access router apparatus, and a step in which in the case where the mobile communication apparatus has determined that the pre-movement source access router apparatus does not comply with Fast Mobile IP when detecting the communication, the mobile communication apparatus acquires information about the movement-destination access router apparatus from an access router information server apparatus storing the information about an access router apparatus, and instructs a home agent apparatus to

forward data addressed to the mobile communication apparatus to the movement-destination access router apparatus. In this way, the mobile communication apparatus can reduce packet loss even when the pre-movement source access route apparatus does not comply with the Fast Mobile IP.

[0023]

Alternatively, the mobile communication method of the present invention further includes a step in which when the mobile communication apparatus has determined that the pre-movement source access router apparatus does not comply with Fast Mobile IP, and that the movement-destination access router apparatus complies with Fast Mobile IP, the mobile communication apparatus instructs the home agent apparatus to forward data addressed to the mobile communication apparatus to the movement-destination access router apparatus, a step in which the home agent apparatus establishes a tunnel between the home agent apparatus and the movement-destination access router apparatus, and notifies the establishment thereof to the mobile communication apparatus, and a step in which the movement-destination access router apparatus forwards the data addressed to the mobile communication data received via the tunnel to the mobile communication apparatus. In this way, the mobile communication apparatus can reduce packet loss even when the pre-movement source access route apparatus does not comply with the Fast Mobile IP.

[0024]

Alternatively, the mobile communication method of the present invention further includes a step in which when the mobile communication

apparatus has determined that the pre-movement source access router apparatus complies with Fast Mobile IP, and that the movement-destination access router apparatus does not comply with Fast Mobile IP, the mobile communication apparatus instructs the pre-movement source access router apparatus to forward data addressed to the mobile communication apparatus to the home agent apparatus, a step in which the pre-movement source access router apparatus establishes a tunnel between the pre-movement source access router apparatus and the home agent apparatus, and notifies the establishment thereof to the mobile communication apparatus, and a step in which the home agent apparatus forwards the data addressed to the mobile communication apparatus received via the tunnel to the mobile communication apparatus. In this way, the mobile communication apparatus can reduce packet loss even when the movement-destination access router does not comply with the Fast Mobile IP.

[0025]

Alternatively, in the mobile communication method of the present invention, the instruction given by the mobile communication apparatus with respect to the pre-movement source access router apparatus is one in which the address of the home agent apparatus is written in the new care-of address field of a fast binding update message according to a Fast Mobile IP procedure. In this way, it becomes unnecessary to define anew a packet format.

[0026]

Alternatively, the mobile communication method of the present

invention further includes a step in which the home agent apparatus starts buffering in the case that buffering is possible when the home agent apparatus receives an instruction from the pre-movement source access router apparatus for buffering transmission data addressed to the mobile communication apparatus. In this way, loss of packets addressed to the mobile communication apparatus can be prevented.

[0027]

Alternatively, the mobile communication method of the present invention further includes a step in which the home agent apparatus notifies the start of the buffering to the pre-movement source access router apparatus. In this way, the pre-movement source access router can know that the buffering is started.

[0028]

Alternatively, in the mobile communication method of the present invention, in the case that the buffering is impossible, the home agent apparatus notifies the pre-movement source access router apparatus that buffering cannot be executed. In this way, the pre-movement source access router can know that the buffering cannot be done by the home agent apparatus.

[0029]

Alternatively, the mobile communication system of the present invention is a mobile communication system including a network having plural sub-networks, access router apparatuses connected to the sub-networks, a mobile communication apparatus making packet-communications with the network through the access router

apparatuses, a home agent apparatus connected to the network which implements mobile management of the mobile communication apparatus moving between sub-networks, and at least one correspondent node connecting to the network, which makes communication with the mobile communication apparatus, in which the access router apparatuses which comply with Fast Mobile IP are intermixed with those which do not comply with it, and the mobile communication apparatus, after moving to a different sub-network, makes a local registration to the home agent apparatus to continue the communication with the correspondent node, in which the mobile communication apparatus has a function of determining whether the access router apparatus complies with Fast Mobile IP or not, and if it determines that the pre-movement source access router apparatus complies with Fast Mobile IP, the mobile communication apparatus acquires information on the movement-destination access router apparatus from the pre-movement source access router apparatus to implement a Fast Mobile IP procedure, and if the mobile communication apparatus determines that the pre-movement source access router apparatus does not comply with Fast Mobile IP, the mobile communication apparatus requests the home agent apparatus for information on the movement-destination access router apparatus, the home agent apparatus provides the information on the movement-destination access router apparatus to the mobile communication apparatus in response to the request, and the mobile communication apparatus instructs the home agent apparatus to forward data addressed to the mobile communication apparatus to the movement-destination access router apparatus. In this way, the mobile communication apparatus can

reduce packet loss even when the pre-movement source access router does not comply with the Fast Mobile IP.

[0030]

Alternatively, the mobile communication system of the present invention is a mobile communication system including a network having plural sub-networks, access router apparatuses connected to the sub-networks, a mobile communication apparatus making packet-communications with the network through the access router apparatuses, a home agent apparatus connected to the network which implements mobile management of the mobile communication apparatus moving between sub-networks, at least one correspondent node connecting to the network, which makes communication with the mobile communication apparatus, and an access router information server apparatus storing information on the access router apparatuses, in which the access router apparatuses which comply with Fast Mobile IP are intermixed with those which do not comply with it, and the mobile communication apparatus, after moving to a different sub-network, makes a local registration to the home agent apparatus to continue the communication with the correspondent node, in which the mobile communication apparatus has a function of determining whether the access router apparatus complies with Fast Mobile IP or not, and if it determines that the pre-movement source access router apparatus complies with Fast Mobile IP, the mobile communication apparatus acquires information on the movement-destination access router apparatus from the pre-movement source access router apparatus to implement a Fast Mobile IP procedure, and if the mobile communication apparatus determines that the

pre-movement source access router apparatus does not comply with Fast Mobile IP, the mobile communication apparatus acquires information on the movement-destination access router apparatus from the access router information server apparatus, and instructs the home agent apparatus to forward data addressed to the mobile communication apparatus to the movement-destination access router apparatus. In this way, the mobile communication apparatus can reduce packet loss even when the pre-movement source access router does not comply with the Fast Mobile IP.

[0031]

Alternatively, the mobile communication apparatus of the present invention is a mobile communication apparatus including a mobile IP/Fast Mobile IP processing part for implementing standard Mobile IP Processing and Fast Mobile IP processing, an access router searching part for acquiring information on access router apparatuses from the mobile IP/Fast Mobile IP processing part, a Fast Mobile IP compliance determining part for determining whether an access router apparatus complies with Fast Mobile IP based on the information acquired at the access router searching part, and a Fast Mobile IP control part for controlling the contents of a message generated by the mobile IP/Fast Mobile IP processing part based on the result of operation of the Fast Mobile IP compliance determining part. In this way, the mobile communication apparatus can reduce packet loss even when the movement-destination access router does not comply with the Fast Mobile IP.

[0032]

Alternatively, in the mobile communication apparatus of the present

invention, the information on the access router apparatuses is acquired from a home agent apparatus which manages movements of the mobile communication apparatus between sub-networks or from an access router apparatus. In this way, the mobile communication apparatus can easily determine whether the movement-destination access router complies with Fast Mobile IP or not.

[0033]

Alternatively, in the mobile communication apparatus of the present invention, if the Fast Mobile IP compliance determining part determines that the pre-movement source access router apparatus does not comply with Fast Mobile IP, the Fast Mobile IP control part gives identifying information of the movement-destination access router apparatus to the home agent apparatus or an access router information server apparatus, and controls the mobile IP/Fast Mobile IP processing part so as to request information on the movement-destination access router apparatus.

[0034]

Alternatively, in the mobile communication apparatus of the present invention, when the Fast Mobile IP compliance determining part determines that the movement-destination access router apparatus complies with Fast Mobile IP, based on the information on the movement-destination access router apparatus obtained from the home agent apparatus, the Fast Mobile IP control part controls the Mobile IP/Fast Mobile IP processing part so that the home agent apparatus forwards data addressed to the mobile communication apparatus to the movement-destination access router apparatus. In this way, the mobile communication apparatus can reduce

packet loss even when the pre-movement source access router does not comply with Fast Mobile IP.

[0035]

Alternatively, in the mobile communication apparatus of the present invention, when the Fast Mobile IP compliance determining part determines that the pre-movement source access router apparatus complies with Fast Mobile IP, and that the movement-destination access router apparatus does not comply with Fast Mobile IP, the Fast Mobile IP control part controls the Mobile IP/Fast Mobile IP processing part so that the pre-movement source access router apparatus forwards data addressed to the mobile communication apparatus to the home agent apparatus. In this way, the mobile communication apparatus can reduce packet loss even when the movement-destination access router does not comply with Fast Mobile IP.

[0036]

Alternatively, in the mobile communication apparatus of the present invention, the Mobile IP/Fast Mobile IP processing part sends a message in which an address of the home agent apparatus is written in the new care-of address field of a fast binding update message according to a Fast Mobile IP procedure to the pre-movement source access router apparatus. In this way, it becomes unnecessary to define anew a packet format.

[0037]

Alternatively, the home agent apparatus of the present invention is a home agent apparatus including a mobile IP/Fast Mobile IP processing part for implementing standard mobile IP processing and fast Mobile IP processing, a buffer memory for temporarily storing data addressed to the

mobile communication apparatus of a management target, and a buffer management part for managing input and output to and from the buffer memory when receiving a request for storing of the data to be sent to the mobile communication apparatus which is received by the mobile IP/Fast Mobile IP processing part or a request for transmission of the stored data. In this way, the mobile communication apparatus can reduce packet loss even when either the pre-movement source access router or the movement-destination access router does not comply with Fast Mobile IP.

[0038]

Alternatively, in the home agent apparatus of the present invention, the buffer management part starts to buffer the packet when it receives a message requesting start of buffering from the pre-movement source access router apparatus, and transmits the buffered packet to the addressed mobile communication apparatus that it receives a message requesting start of transmission of the buffered packet from the movement-destination access router apparatus. In this way, loss of packets addressed to the mobile communication apparatus can be prevented.

[0039]

Alternatively, the home agent apparatus of the present invention further includes a movement-destination access router searching part for requesting the access router information server apparatus which stores information on access router apparatuses for information on the movement-destination access router in response to the inquiry of information on the movement-destination access router apparatus, and giving the acquired information to the requesting apparatus. In this way, it becomes

unnecessary for the home agent apparatus to store information on access routers.

[0040]

Alternatively, in the home agent apparatus of the present invention, the movement-destination access router searching part makes a request to the access router information server apparatus based on an identifier flag of the movement-destination access router apparatus acquired when the movement-destination access router searching part receives the request from the mobile communication apparatus. In this way, the home agent apparatus can easily acquire information on the movement-destination access router of the mobile communication apparatus.

[0041]

Alternatively, the home agent apparatus of the present invention further includes an access router information list in which identifier tags of access router apparatuses, IP addresses of the access router apparatuses, and compliance and/or noncompliance with Fast Mobile IP of the access router apparatuses are written, and an access router information searching part for searching for entries corresponding to the identifier tag included in the received message requesting information on an access router apparatus, wherein the movement-destination access router searching part instructs the access router information searching part to search for information on the movement-destination access router apparatus in response to the request. In this way, the home agent apparatus can easily acquire information on the movement-destination access router of the mobile communication apparatus.

[0042]

Alternatively, in the home agent apparatus of the present invention, the identifier tag of the access router is at least either a lower layer address or a cell station ID. In this way, the home agent apparatus can uniquely identify the movement-destination access router.

[0043]

Alternatively, the access router information server apparatus of the present invention is an access router information server apparatus including an access router information list in which identifier tags of access router apparatuses, IP addresses of the access router apparatuses, and compliance and/or noncompliance with Fast Mobile IP of the access router apparatuses are written, a receiving part for receiving requests for information on the access router apparatuses from various kinds of apparatuses on the network, an access router information searching part for searching the access router information list for entries corresponding to the identifier tag included in the received request, and an access router information notifying part for notifying the search result to the requesting apparatus. In this way, the mobile communication apparatus can acquire information on the movement-destination access router only by sending a message requesting information on the movement-destination access router apparatus to the access router information server apparatus.

[0044]

Alternatively, in the access router information server apparatus of the present invention, the identifier tag of the access router is either a lower layer address or a cell station ID. In this way, the access router information server apparatus can uniquely identify the movement-destination access

router.

[Advantage of the Invention]

[0045]

As described herein, according to the mobile communication method of the present invention, when the mobile communication apparatus moves to a different sub-network, it is possible to choose an appropriate forwarding method in accordance with compliance/noncompliance with Fast Mobile IP of the pre-movement source access router apparatus and the movement-destination access router apparatus, and even when neither of them complies with Fast Mobile IP, packet loss can be reduced.

[Best Mode for Carrying Out the Invention]

[0046]

Hereinafter, preferred embodiments of the present invention will be explained with reference to the drawings. Note that identical configuration blocks are denoted by identical reference numerals in the following drawings.

[0047]

(Preferred Embodiment 1)

Fig. 1 is a configuration view of a mobile communication system according to the present invention. In Fig. 1, Internet 1 is a network composed of a plurality of routers and hosts to which an Internet Protocol is applied, local networks 10, 11 are connected to the Internet, and are networks composed of a plurality of routers and hosts to which an Internet Protocol is applied, mobile communication apparatus 20 performs communications using the Internet Protocol, correspondent node 80

performs communications with mobile communication apparatus 20, home agent apparatus 40 performs location management of mobile communication apparatus 20, access router apparatuses 100a to 100c are connected to local network 10, and access router apparatuses 100d to 100f are connected to local network 11.

[0048]

In preferred embodiment 1 of the present invention, it is explained that local network 10 complies with Fast Mobile IP, and that local network 11 does not comply with Fast Mobile IP. That is, access route apparatuses 100a to 100c connected to local network 10 can process messages used in a Fast Mobile IP procedure, and can implement buffering of packets and forwarding to mobile communication apparatus 20. On the other hand, access route apparatuses 100d to 100f connected to local network 11 cannot process messages used in a Fast Mobile IP procedure, and cannot implement buffering of packets and forwarding to mobile communication apparatus 20.

[0049]

In the mobile communication system of the present invention, the operation of mobile communication apparatus 20 moving from access router apparatus 100c to access router apparatus 100d is explained below while referring to the sequence diagram in Fig. 6 and Fig. 7.

[0050]

Fig. 6 is a sequence diagram in which the route is optimized from correspondent node 80 to mobile communication apparatus 20, and Fig. 7 is a sequence diagram in which the route is not optimized. Optimizing of route means that the transmission data from correspondent node 80 to mobile

communication apparatus 20 is directly transmitted to the care-of address of mobile communication apparatus 20 at the present without passing through the home address belonging to the home network of mobile communication apparatus 20.

[0051]

When determining the start of handover, mobile communication apparatus 20 operates as follows (step S401). The handover trigger can be issued, for example, at a lower layer when receiving a beacon signal from access router apparatus 100d different from access router apparatus 100c being connected at the present (or an access point apparatus such as cell station). When determining the handover start by a beacon signal, mobile communication apparatus 20 judges if a lower layer address of access router apparatus 100d (MAC address or cell station ID) from the received beacon signal. Or mobile communication apparatus 20 judges if access router apparatus 108 complies with Fast Mobile IP or not. To judge whether access router apparatus 100c compiles with Fast Mobile IP or not, for example, by referring to router advertisement message 2400 transmitted from access router apparatus 100c, it is judged from the information of an option region showing whether complying with Fast Mobile IP or not contained in router advertisement message 2400. For example, when the value is 0 in code field 2402 of handover capability extension 2401 shown in Fig. 22, it shows that the access router apparatus complies with Fast Mobile IP. Or, after mobile communication apparatus 20 has sent a proxy router solicitation message, if there is no reply for a certain number of times, it is judged that access router apparatus 100c does not comply with Fast Mobile

IP. In this preferred embodiment, since access router apparatus 100c complies with Fast Mobile IP, mobile communication apparatus 20 transmits proxy router solicitation message (RtSolPr) 1400 to access router apparatus 100c (step S402). Fig. 27 shows a format of proxy router solicitation message 1400.

[0052]

When mobile communication apparatus 20 can obtain a lower layer address (that is, MAC address) from the received beacon signal, it is described in New LLA field 1401 of proxy router solicitation message 1400. Meanwhile, as shown in Fig. 27, an IP header is added to the message, and it is the same as used generally. This is the same in the following messages.

[0053]

Access router apparatus 100c receives proxy router solicitation message 1400 from mobile communication apparatus 20 (step S402), and searches for information on movement-destination access router apparatus 100d. At this time, access router apparatus 100c searches on the basis of lower layer address if lower layer address is included in proxy router solicitation message 1400. This searching is either searching from the access router information list holding the information on the access router apparatuses with the same sub-network held by access router apparatus 100c, or inquiry into access router information server apparatus 60 storing the information on access router apparatuses within the network (step S420).

[0054]

The configuration of access router information list of the present

invention is shown in Fig. 14 (a), (b), (c). In Fig. 4 (a), (b), (c), lower layer address 1301 is a lower layer address of the corresponding access router apparatus, IP address 1302 is an IP address of the corresponding access router apparatus, and flag 1303 is a flag showing that the corresponding access router apparatus compiles with Fast Mobile IP.

[0055]

Access router information server apparatus 60 holds the information on access router apparatuses, and searches and replies the information of IP address or the like of a desired access router apparatus according to the request. As a result of searching, if failing to discover information on the desired access router apparatus, or if the information on movement-destination access router 100d, although discovered, is found not to comply with Fast Mobile IP, access router apparatus 100c sends a code showing that the information on movement-destination access router 100d cannot be discovered, or that the discovered information does not comply with Fast Mobile IP to mobile communication apparatus 20 as proxy router advertisement message 1500 described in code field 1501 shown in Fig. 28 (step S403). Alternatively, handover capability option 2401 of router advertisement message 2400 may be added to proxy router advertisement message 2400, and the message showing Fast Mobile IP compliance of the discovered movement-destination access router apparatus 100d may be transmitted to code field 2402, and same effects as mentioned above may be obtained.

[0056]

Mobile communication apparatus 20 refers to code field 1501

contained in proxy router advertisement message 1500, and judges if the information on access router apparatus 100d can be acquired or not, or if access router apparatus 100d complies with Fast Mobile IP or not. Or, when handover capability option 2401 is added, by referring to code field 2402, compliance of access router apparatus 100d with Fast Mobile IP is confirmed.

[0057]

Since pre-movement source access router apparatus 100c complies with Fast Mobile IP, mobile communication apparatus 20 transmits fast binding update message FBU to access router apparatus 100c, thereby notifying that mobile communication apparatus 20 starts a Fast Mobile IP procedure (step S404).

[0058]

Fig. 29 shows a packet format of fast binding update message 1600. In this format, mobile communication apparatus 20 describes the IP address of home agent apparatus 40 to which mobile communication apparatus 20 belongs, in proxy care-of address field 1601 in fast binding update message 1600.

[0059]

Access router apparatus 100c receives this fast binding update message 1600 (step S404), and transmits handover initiate message (HI) 1700 to the address described in proxy care-of address field 1601 in fast binding update message 1600, that is, to home agent apparatus 40 (step S405).

[0060]

Fig. 32 shows a packet format of handover initiate message 1700. Herein, in previous care-of address field (previous CoA) 1701 in handover initiate message 1700, the present care-of address is described, and U-flag 1703 instructing buffering of packet is set in home agent apparatus 40. When buffering is not requested, setting of U-flag 1703 is not necessary.

[0061]

Home agent apparatus 40 receives handover initiate message 1700 from access router apparatus 100c, and confirms that the home address corresponding to the care-of address described in previous care-of address field 1701 of handover initiate message 1700, that is, the home address of mobile communication apparatus 20 is present in the binding cache. Fig. 4 shows a data configuration of the binding cache. Home address 2301 is the home address of the node managed by this home agent apparatus 40, care-of address 2302 is the address of the node in the network other than the sub-network to which the home agent apparatus belongs, sequence number 2303 is the maximum value of sequence number of the binding update message received previously, and life time 2304 shows the valid term of the node registered in this binding cache. In this case, home agent apparatus 40 checks if the address of previous care-of address field 1701 is present in home address 2301 or not. If U-flag 1703 instructing buffering of handover initiate message 1700 is being set, buffering of packet of the corresponding care-of address and packet of home address of mobile communication apparatus 20 is started.

[0062]

Herein, if the communication route from correspondent node 80 to

mobile communication apparatus 20 is optimized, as shown in Fig. 6, correspondent node 80 transmits the data packet directly to access router apparatus 100c, not to home agent apparatus 40 (step S417). Since access router apparatus 100c has received fast binding update message 1600, the received data packet addressed to mobile communication apparatus 20 is forwarded to home agent apparatus 40.

[0063]

On the other hand, if the communication route is not optimized, as shown in Fig. 7, the data packet is transmitted from correspondent node 80 to home agent apparatus 40 (step S419).

[0064]

In consequence, home agent apparatus 40 buffers this forwarded data packet addressed to mobile communication apparatus 20 (step S408).

[0065]

Further, home agent apparatus 40 transmits handover acknowledgement message (HACK) 1800 to access router apparatus 100c showing that the handover process is done successfully (step S406). Fig. 33 shows a format of handover acknowledgement message 1800.

[0066]

Access router apparatus 100c, after receiving of handover acknowledgement message 1800, transmits fast binding acknowledgement message (FBACK) to mobile communication apparatus 20 (step S407). Fig. 23 shows a format of fast binding acknowledgement message 1900.

[0067]

In this period, the packet transmitted from correspondent node 80 to

the home address of mobile communication apparatus 20 is buffered by the home agent apparatus as mentioned above (step S408).

[0068]

Next, mobile communication apparatus 20, after receiving fast binding acknowledgement message 1900 from access router apparatus 100c, performs the handover process in the lower layer (step S409). Then, mobile communication apparatus 20, after finishing the handover process in the lower layer, transmits a router solicitation message (RtSol) to movement-destination access router apparatus 100d (step S410).

[0069]

Access route apparatus 100d, after receiving this router solicitation message, transmits a router advertisement message including at least the own sub-network prefix to mobile communication apparatus 20 (step S411).

[0070]

After receiving this router advertisement message from access router apparatus 100d, mobile communication apparatus 20 generates a care-of address (step S421). Then, mobile communication apparatus 20 transmits binding update message (BU) 2200 including the care-of address generated by way of access router apparatus 100d and the own home address to home agent apparatus 40, and notifies the care-of address of the movement destination (step S412). Fig. 26 shows a format of binding update message 2200. The own home address is written in home address field 2201, and the care-of address is written in source address field 2203.

[0071]

Next, home agent apparatus 40, after receiving this binding update

message 2200 (step S412), updates binding cache 2300, and starts transmission of the packet being buffered to a new care-of address (step S414). Then, home agent apparatus 40 transmits a binding acknowledgement message (BA) to mobile communication apparatus 20 by way of access router apparatus 100d (step S413).

[0072]

Mobile communication apparatus 20 receives the binding acknowledgement message from home agent apparatus 40 (step S413), and confirms complication of location registration.

[0073]

Furthermore, mobile communication apparatus 20 transmits binding update message 2200 to correspondent node 80 according to a standard mobile IP procedure (step S415). Correspondent node 80, after receiving binding update message 2200, updates binging cache 2300 being held, and communicates directly with mobile communication apparatus 20 (step S416).

[0074]

The packet format is not limited to the one explained herein, but other format may be used as far as similar effects are obtained. (Mobile communication apparatus).

The configuration and operations of mobile communication apparatus 20 of the present invention are specifically described below while referring to the accompanying drawing.

[0075]

Fig. 2 is a configuration diagram of mobile communication apparatus 20 of the present invention. In Fig. 2, lower layer processing parts 21, 22

perform processes such as modulation, demodulation, and access control, IP processing part 23 performs packet forwarding or the like by using the Internet Protocol (IP), and upper layer processing part 24 performs the control of applications and the management of sessions at layers higher than the IP layer. Mobile IP/Fast Mobile IP processing part 25 implements procedures of standard mobile IP and Fast Mobile IP, Fast Mobile IP control part 26 performs the control of mobile IP/Fast Mobile IP processing part 25, with respect to Fast Mobile IP, Fast Mobile IP compliance determining part 27 determines whether the access router apparatus of a connection destination complies with Fast Mobile IP or not, and access router searching part 28 acquires information on access router apparatuses of prospective new destinations, to determine a movement-destination access router. Concerning lower layer processing parts 21, 22, it is sufficient to have at least one part, and it is not always necessary to have two or more.

[0076]

Operations of mobile communication apparatus 20 having such configuration are explained in detail below with reference to operation flowcharts in Fig. 8 and Fig. 9.

[0077]

First, when mobile IP/Fast Mobile IP processing part 25 detects that a connection to access router apparatus 100d different from access router apparatus 100c which is currently connected is possible, it issues a handover start trigger (step S601). The handover start trigger can be issued at a lower layer or can be issued at an upper layer where there are applications. For example, in the case that the lower layer is IEEE802.11, the reception of

a beacon signal from a different access router apparatus (or an access point apparatus connected to the access router apparatus) is regarded as the trigger.

[0078]

Hereupon, mobile IP/Fast Mobile IP processing part 25 acquires an identifier tag (ID) of access router apparatus 100d which is to be the movement destination in the case that it can be acquired when the handover start trigger is issued (step S602). For example, the lower layer address included in the received beacon signals is acquired as the identifier tag. However, other identifier tags may be acquired such as cell station ID.

[0079]

When the identifier tag of movement-destination access router apparatus 100d cannot be acquired, mobile IP/Fast Mobile IP processing part 25 transmits buffering request message 2000 to home agent apparatus 40, and requests to buffer the packet addressed the home address of mobile communication apparatus 20 (step S603). Fig. 24 shows a format of buffering request message 2000. The message includes B-flag 2001 showing the request of buffering, and the own home address of mobile communication apparatus 20 is written in home address field 2002.

[0080]

When the identifier tag of movement-destination access router apparatus 100d can be acquired, Fast Mobile IP compliance determining part 27 verifies whether pre-movement source access router apparatus 100c complies with Fast Mobile IP or not (step S604). The compliance/noncompliance with Fast Mobile IP is indicated by the value

written in code field 2402 in handover capability option 2401, which is added to router advertisement message 2400 received from pre-movement source access router apparatus 100c. Alternatively, when there is no reply to a specific number of times after mobile communication apparatus 20 has transmitted a proxy router solicitation message, it is determined that pre-movement source access router apparatus 100c does not comply with Fast Mobile IP.

[0081]

Note that the verification whether pre-movement source access router apparatus 100c complies with Fast Mobile IP can be executed in advance, and in that case, it is necessary to store the compliance separately.

[0082]

In the preferred embodiment, pre-movement source access router apparatus 100c complies with Fast Mobile IP, and "0" is set in code field 2402 before its transmission, Fast Mobile IP compliance determining part 27 determines that pre-movement source access router apparatus 100c complies with Fast Mobile IP, and sends the judging result to Fast Mobile IP control part 26.

[0083]

Fast Mobile IP control part 26 instructs mobile IP/Fast Mobile IP processing part 25 to transmit proxy router solicitation message 1400 to pre-movement source access router apparatus 100c, and mobile IP/Fast Mobile IP processing part 25 performs the process of generating and sending the message (step S606). At this time, the identifier tag of movement-destination access router apparatus 100d is written in proxy

router solicitation message 1400. In particular, in the case that the identifier tag is the lower layer address, it is written in new LLA field 1401. Proxy router solicitation message 1400 is sent from mobile IP/Fast Mobile IP processing part 25 to IP processing part 23, and forwarded to the network from selected lower layer processing part 21 or 22.

[0084]

Operations from reception of proxy router advertisement message 1500 till reception of data packet being buffered in home agent apparatus 40 are explained by referring to Fig. 9.

[0085]

First, when mobile IP/Fast Mobile IP processing part 25 receives proxy router advertisement message (PrRtAdv) 1500 as a reply to proxy router solicitation message 1400 (step S701), it verifies if information on movement-destination access router apparatus 100d is contained or not (step S702), and if contained, it is notified to access router searching part 28. For example, it is verified if new router prefix field 1502 includes the IP address of movement-destination access route apparatus 100d or the network prefix managed by movement-destination access route apparatus 100d.

[0086]

If information on movement-destination access route apparatus 100d is not included, mobile IP/Fast Mobile IP processing part 25 transmits buffering request message 2000 to the home agent apparatus (step S703).

[0087]

If information on movement-destination access route apparatus 100d is included, it is judged if the transmission destination of proxy router

advertisement message 1500 is pre-movement source access router apparatus 100c or not (step S704). In the preferred embodiment, since access router apparatus 100c complies with Fast Mobile IP, in succession, Fast Mobile IP compliance determining part 27 verifies compliance with Fast Mobile IP of movement-destination access route apparatus 100d (step S708). The verification is done by referring to code field 1501 of proxy router advertisement message 1500 as mentioned above, or handover capability option 2401 not shown.

[0088]

When it is verified that movement-destination access route apparatus 100d does not comply with Fast Mobile IP, Fast Mobile IP control part 26 writes the IP address of home agent apparatus 40 of mobile communication apparatus 20 itself in proxy care-of address field 1601 of fast binding update message 1600 (or the home address of mobile communication apparatus 210 itself), and transmits to pre-movement source access router apparatus 100c (step S709).

[0089]

When movement-destination access route apparatus 100d complies with Fast Mobile IP, Fast Mobile IP control part 26 instructs mobile IP/Fast Mobile IP processing part 25 to implement a Fast Mobile IP procedure. That is, mobile IP/Fast Mobile IP processing part 25 transmits, to pre-movement source access router apparatus 100c, fast binding update message 1600 in whose replacement care-of address field 1601 is written the IP address of movement-destination access router apparatus 100d (or the IP address of mobile communication apparatus 20 which can be used when

connecting to movement-destination access router apparatus 100d) as the IP address of the access router apparatus to be the handover destination (step S710).

[0090]

As a reply to fast binding update message 1600, when fast binding acknowledgement message 1900 is received (step S711), mobile IP/Fast Mobile IP processing part 25 instructs start of handover process to lower layer processing part 21 and/or 22, and lower layer processing part 21 and/or 22 executes the handover processing. Further, when the handover in the lower layer is completed, a connection process such as acquiring a new care-of address of IP processing part 23 is carried out (step S712). After acquiring the new care-of address, the mobile IP/Fast Mobile IP processing part performs a binding update processing with respect to home agent apparatus 40 based on the standard mobile IP procedure (step S713).

[0091]

Herein, when fast binding update message 1600 specifying home agent apparatus 40 (or home address of mobile communication apparatus 20 itself) has been transmitted previously, after completion of binding update processing (step S713), the packets stored in home agent apparatus 40 are forwarded, and they are received by IP processing part 23 (step S714).

[0092]

In the case that the standard Fast Mobile IP procedure has been previously executed, namely, fast binding update message 1600 in which the IP address of movement-destination access router apparatus 100d is written has been sent, stored packets are forwarded after the handover processing

(step S712) is completed, and IP processing part 23 receives the packets. Mobile communication apparatus 20 may acquire identifier tags of plural access router apparatuses 100 and may acquire information on them. Specifically, access router searching part 28 acquires information used for selecting priority 1304, transmission rate 1305 or the like in access router information list 1300 such as shown in Fig. 14 (b) or (c) by requesting it from home agent apparatus 40, access router information server apparatus 60 or access router apparatus 100, at which information on the access router apparatus is acquired, and can compare and select according to the request from the upper layer including the applications. For example, in the case that transmission rate value 1305 shown in Fig. 14 (c) is acquired together with other information on the movement-destination access router and there is transmission and reception of large data, access router apparatus 100 with the lower layer address "2", whose transmission rate value 1305 is 100Mbps, is decided as the movement-destination access router apparatus, thereby realizing a smooth handover.

[0093]

However, since movement-destination access router apparatus 100d decided here does not comply with Fast Mobile IP, it is necessary to apply the procedure as described above.

[0094]

As described above, according to the mobile communication apparatus of the present invention, in a network environment in which the access router apparatuses which comply with Fast Mobile IP and the access router apparatuses which do not comply with Fast Mobile IP are intermixed,

even when the movement-destination access router does not comply with Fast Mobile IP, packet loss can be eliminated in the same way as in Fast Mobile IP by passing through the home agent apparatus, and forwarding efficiency during the handover in the mobile communication system can be improved.

(Home agent apparatus)

Next, the configuration and operation of home agent apparatus 40 according to the present invention will be explained with reference to the drawings.

[0095]

Fig. 3 is a configuration diagram of home agent apparatus 40 according to the present invention. In Fig. 3, lower layer processing parts 41, 42 perform processes such as modulation and demodulation or the access control, IP processing part 43 performs a packet forwarding and the like using the Internet Protocol (IP), and upper layer processing part 44 performs the control of applications and the management of sessions at layers higher than the IP layer. Mobile IP/Fast Mobile IP processing part 45 implements procedures of the standard mobile IP and Fast Mobile IP, buffer memory 47 temporarily stores packets addressed to mobile communication apparatus 20, and buffer management part 46 manages input and output of the buffer.

[0096]

Concerning lower layer processing parts 41, 42, it is sufficient to have at least one part, and it is not always necessary to have two or more.

[0097]

Operations of home agent apparatus 40 having such configuration

are explained in detail below with reference to operation flowcharts in Fig. 10 to Fig. 12.

[0098]

When home agent apparatus 40 receives a predetermined message from mobile communication apparatus 20 or access router apparatus 100, it starts the specified operation. Hereinafter, operations for each of the received messages will be explained.

[0099]

Fig. 10 is an operation flowchart showing operations when home agent apparatus 40 has received buffering request message 2000 transmitted by mobile communication apparatus 20.

[0100]

Mobile IP/Fast Mobile IP processing part 45 checks whether buffering request message 2000 has been received or not through lower layer processing parts 41, 42 and IP processing part 43 (step S901), and if it has been received, it is notified to buffer management part 46.

[0101]

Next, buffer management part 46 verifies the status of buffer memory 47 and determines whether the buffering is possible (step S902).

[0102]

If buffer management part 46 determines that the buffering is impossible for a reason such as limited buffer capacity, this is indicated in status field 2101 of buffering reply message 2100 which is sent to mobile communication apparatus 20 (step S903).

[0103]

In the case that the buffering is determined to be possible, from that time onward, IP processing part 43 forwards packets addressed to mobile communication apparatus 20 to buffer management part 46, and buffer management part 46 stores the packets in buffer 47 (step S904). In addition, buffering reply message 2100 in which the start of buffering is indicated in status field 2101 is transmitted to mobile communication apparatus 20 (step S905). After that, the processing returns to step S901.

[0104]

Fig. 11 is an operation flowchart showing operations when home agent apparatus 40 has received handover initiate message 1700 transmitted by the access router apparatus.

[0105]

When mobile IP/Fast Mobile IP processing part 45 receives handover initiate message 1700 through lower layer processing parts 41, 42 and IP processing part 43 (step 1001), it verifies U-flag 1703 which requests the buffering (step S1002). In the case there is a buffering request, from that time onward, IP processing part 43 forwards packets addressed to mobile communication apparatus 20 to buffer management part 46, and buffer management part 46 starts the process of storing the packets in buffer 47 (step S1003). Then, buffer management part 46 sends handover acknowledgement message 1800 to mobile communication apparatus 20, in which a status code including the information indicating the start of buffering is written in code field 1801 (step 1004). In the case that the buffering is judged to be impossible in step S1003, this is indicated in code field 1801 of handover acknowledgement message 1800 and sent to mobile

communication apparatus 20 (step S1004).

[0106]

In step S1002, if there is no buffering request, buffer management part 46 transmits handover acknowledgement message 1800 in which a prescribed status code is written in code field 1801, to mobile communication apparatus 20 (step S1004).

[0107]

Fig. 12 is an operation flowchart showing operations when home agent apparatus 40 receives binding update message 2200 transmitted by mobile communication apparatus 20.

[0108]

When mobile IP/Fast Mobile IP processing part 45 receives binding update message 2200 through lower layer processing parts 41, 42 and IP processing part 43 (step 1200), it verifies if T-flag 2202 requesting forwarding of the buffered packet is set or not (step S1201). In the case that T-flag 2202 is not set, mobile IP/Fast Mobile IP processing part 45 processes binding update message 2200 according to the standard mobile IP procedure (step S1204). After that, the processing returns to step S1200.

[0109]

In the case that F-flag 2202 is set, mobile IP/Fast Mobile IP processing part 45 notifies to buffer management part 46, and buffer management part 46 checks whether packets addressed to mobile communication apparatus 20 are stored in buffer 47 (step S1202). If stored, the packets are forwarded to IP processing part 43 to be transmitted to mobile communication apparatus 20 (step S1203).

[0110]

Further, mobile IP/Fast Mobile IP processing part 45 processes binding update message 2200 in accordance with the standard mobile IP procedure (step S1204).

[0111]

Even when there are no stored packets, mobile IP/Fast Mobile IP processing part 45 further processes binding update message 2200 in accordance with the standard mobile IP procedure (step S1204).

[0112]

Even in the case that there is no T-flag 2202, by receiving binding update message 2200 from mobile communication apparatus 20 for which buffering is being carried out, it can be verified that a new communication route has been secured, and therefore buffered packets can be forwarded.

(Access router information server apparatus)

The configuration and operations of access router information server apparatus 60 of the present invention are explained with reference to the drawings.

[0113]

Fig. 5 is a configuration diagram of access router information server apparatus 60 according to the present invention. In Fig. 5, lower layer processing parts 61, 62 perform processes such as modulation and demodulation or the access control, IP processing part 63 performs a packet forwarding and the like using the Internet Protocol (IP), and upper layer processing part 64 performs the control of applications and the management of sessions at layers higher than the IP layer. Access router information list

65 stores the information of the access routers, access router information searching part 66 searches for information on access routers from the access router information list, and access router information notifying part 67 notifies the mobile communication apparatus of the search result of access router information searching part 66. Concerning lower layer processing parts 61, 62, it is sufficient to have at least one part, and it is not always necessary to have two or more.

[0114]

Operations of access router information server apparatus 60 having such configuration are explained in detail below with reference to operation flowchart in Fig. 13.

[0115]

When access router information server apparatus 60 receives a predetermined message from mobile communication apparatus 20, home agent apparatus 40 or access router apparatus 100, it starts the specified operation. Hereinafter, operations for each of the received messages will be explained.

[0116]

Fig. 13 is an operation flowchart when receiving request message 2500 transmitted from mobile communication apparatus 20, home agent apparatus 40 or access router apparatus 100.

[0117]

First, when access router information searching part 66 receives request message 2500 through lower layer processing parts 61, 62, IP processing part 63, and upper layer processing part 64 (step S1300), it

searches for the indicated information in access router information list 65 (step S1301). Fig. 30 shows a format of request message 2500.

[0118]

The access router information list has, for example, a configuration shown in Fig. 14 (a), and includes information showing lower layer address 1301, IP address 1302, and Fast Mobile IP compliance/noncompliance 1303 of access router apparatus 100. Further, it can include additional information as shown in Fig. 14 (b), that is, information such as priority value 1304 used when selecting access router apparatus 100 or transmission rate value 1305 provided by each access router apparatus 100 shown in Fig. 14 (c).

[0119]

In search of information, it is intended to search at least IP address 1302 corresponding to lower layer address 1301 matching lower layer address 2501 included in request message 2500 in the access router information list.

[0120]

Next, access router information notifying part 67 transmits reply message 2600 in which the obtained information is written to the transmission source of the request message (step 1302). Fig. 31 shows a format of reply message 2600. The searched IP address is written in address field 2601.

[0121]

When additional information such as the priority or the transmission rate is included in the reply message, the replay message can include fields

in which additional information such as the priority or the transmission rate can be written. The packet format is not limited to the shown example alone, but may include another format as far as same effects are obtained.

[0122]

According to the access router information server apparatus of the present invention, information on the access router apparatus such as compliance/noncompliance information with Fast Mobile IP, additional information such as the priority value or the transmission rate which may be referred to when selecting the movement-destination access router can be provided. In this way, the mobile communication apparatus receives the information allowing flexible selection of the movement-destination access router apparatus, and therefore in the mobile communication system according to the present invention, the handover which is suitable for the upper layer where there are applications can be realized.

[0123]

As described herein, according to the preferred embodiment, in a network environment in which the access router apparatuses which comply with Fast Mobile IP and the access router apparatuses which do not comply with Fast Mobile IP are intermixed, the mobile communication apparatus judges whether the pre-movement source access router apparatus and the movement-destination access router apparatus comply with Fast Mobile IP or not, and if the movement-destination access router does not comply with Fast Mobile IP, the mobile communication apparatus specifies the home agent apparatus as the proxy for the movement-destination access router apparatus, and implements the Fast Mobile IP procedure, and hence

handover free from packet loss is realized, and when both access router apparatuses comply with Fast Mobile IP, since both can exchange Fast Mobile IP, the forwarding efficiency in handover can be enhanced.

[0124]

(Preferred Embodiment 2)

Fig. 15 is a configuration diagram of a mobile communication system of this preferred embodiment, and it is similar to preferred embodiment 1 except that home agent apparatus 40a has a function of searching the movement-destination access router apparatus.

[0125]

In preferred embodiment 2 of the present invention, it is supposed that mobile communication apparatus 20 moves from local network 11 not complying with Fast Mobile IP to local network 10 complying with Fast Mobile IP. In the following explanation, the message format is same as shown in preferred embodiment 1.

[0126]

Fig. 16 and Fig. 17 are sequence diagrams for explaining the operation of the preferred embodiment. Fig. 16 shows the operation in the state in which the communication route is not optimized from correspondent node 80 to mobile communication apparatus 20, and the data packet to mobile communication apparatus 20 is transmitted to the home address. Home agent apparatus 40 forwards the data packet to access router apparatus 100d being connected at the present, and access router apparatus 100d further forwards to mobile communication apparatus 20.

[0127]

On the other hand, Fig. 17 shows the operation in the state in which the communication route is optimized from correspondent node 80 to mobile communication apparatus 20, and the data packet to mobile communication apparatus 20 is transmitted directly to access router apparatus 100d, and access router apparatus 100d further forwards to mobile communication apparatus 20.

[0128]

First, mobile communication apparatus 20 determines the start of handover same as in preferred embodiment 1 (step S501). At this time, if the route shown in Fig. 17 is optimized, mobile communication apparatus 20 transmits binding update message 2200 in which "0" is set in life time field to correspondent node 80, and the binding of mobile communication apparatus 20 and access router apparatus 100d is canceled to be set in non-optimized state. As a result, by the following processing, it is possible to eliminate loss of data packet from correspondent node 80 to mobile communication apparatus 20 in the handover process.

[0129]

Then, when mobile communication apparatus 20 determines the handover start by beacon signal, it is verified whether the lower layer address of access router apparatus 100c can be acquired form the received beacon signal or not. Or mobile communication apparatus 20 judges if access router apparatus 100d complies with Fast Mobile IP or not. In the preferred embodiment, since access router apparatus 100d does not comply with Fast Mobile IP, mobile communication apparatus 20 transmits proxy router solicitation message (RtSolPr) 1400 to home agent apparatus 40 by

way of access router apparatus 100d (step S502). When the lower layer address can be acquired from the received beacon signal, this lower layer address is written in new LLA field 1401 of proxy router solicitation message 1400.

[0130]

Home agent apparatus 40, after receiving proxy router solicitation message 1400 from mobile communication apparatus 20, searches for information on movement-destination access router apparatus 100c. At this time, if the lower layer address is included in proxy router solicitation message 1400, it is searched on the basis of the lower layer address. This search is performed by searching in the access router information list in which information on access router apparatuses is stored, or by inquiring of access router information server apparatus 60 in which information on access router apparatuses in the network is stored (step S520).

[0131]

As a result of the search, when an entry corresponding to the lower layer address can be found and it is determined that there is compliance with Fast Mobile IP, home agent apparatus 40 sends proxy router advertisement message (PrRtAdvv) 1500 in whose new router prefix field 1502 is written the IP address obtained from information on access router apparatus 100c which corresponds to the lower layer address (step S503).

[0132]

Next, mobile communication apparatus 20 receives proxy router advertisement message 1500 through access router apparatus 100d to acquire the IP address written in new router prefix field 1502 as the

information on movement-destination access router apparatus 100c. Subsequently, mobile communication apparatus 20 sends fast binding update message (FBU) 1600 to home agent apparatus 40 through access router apparatus 100d (step S504). At this time, a global address of home agent apparatus 40 is written as the destination address of fast binding update message 1600. The IP address included in the information on movement-destination access router apparatus 100c which has been previously acquired is written in replacement care-of address field 1601 of fast binding update message 1600

[0133]

The acquirement of information on the movement-destination access router apparatus can be directly performed by mobile communication apparatus 20. In that case, mobile communication apparatus 20 does not execute the processes of step S502 and step S503, and the process of step S520 is initiated by mobile communication apparatus 20 itself, and is executed through interaction between it and access router information server apparatus 60, and the process of step S504 is performed on the basis of the obtained information.

[0134]

Next, home agent apparatus 40, after receiving fast binding update message 1600, transmits handover initiate message (HI) 1700 to the address indicated in replacement care-of address field 1601 of fast binding update message 1600, that is, to movement-destination access router apparatus 100d (step S505). At this time, the current care-of address of mobile communication apparatus 20 is written in old care-of address field 1701 of

handover initiate message 1700, and U-flag 1703 for instructing access router apparatus 100c to buffer packets is set. If buffering is not requested, setting of U-flag 1703 is not needed. Note that home agent apparatus 40 updates the binding cache also at this time.

[0135]

Next, movement-destination access router apparatus 100c, after receiving handover initiate message 1700 from home agent apparatus 40, starts to buffer packets addressed to the care-of address of mobile communication apparatus 20 received from that time, because U-flag 1703 for instructing the buffering is set in handover initiate message 1700. Specifically, when home agent apparatus 40 receives data packets addressed to the home address of mobile communication apparatus 20 (S518) and forwards them to access router apparatus 100c (step S519), access router apparatus 100c verifies that the packets are addressed to mobile communication apparatus 20 and performs buffering (step S508).

[0136]

At that time, access router apparatus 100c sends handover acknowledgement message (HACK) 1800 indicating that the handover process is successful to home agent apparatus 40 (step S506).

[0137]

Next, home agent apparatus 40, after receiving handover acknowledgement message 1800, sends fast binding acknowledgement message (FBACK) 1900 to mobile communication apparatus 20 through access router apparatus 100d (step S507). Meanwhile, packets addressed to the home address of mobile communication apparatus 20 and sent from

correspondent node 80 are buffered by access router apparatus 100c as described above (step S508).

[0138]

Next, mobile communication apparatus 20, after receiving fast binding acknowledgement message 1800 from access router apparatus 100d (step S507), performs the handover process in the lower layer (step S509).

[0139]

After completion of the handover process in the lower layer, mobile communication apparatus 20 transmits a router solicitation message (RtSol) to movement-destination access router apparatus 100c (step S510).

[0140]

Movement-destination access router apparatus 100c receives this router solicitation message, and then transmits the buffered packets to mobile communication apparatus 20 (step S511).

[0141]

Movement-destination access router apparatus 100c transmits a router advertisement message including at least the own sub-network prefix of movement-destination access router apparatus 100c to mobile communication apparatus 20 (step S512).

[0142]

Next, mobile communication apparatus 20, after receiving the router advertisement message from movement-destination access router apparatus 100c, generates a care-of address (step S520), and transmits binding update message BU 2200 including the generated care-of address and the own home address of mobile communication apparatus 20 to home agent apparatus 40

through access router apparatus 100c (step S513).

[0143]

Home agent apparatus 40 receives binding update message 2200 (step S513), and updates binding cache 2300. After that, it sends a binding acknowledgement message BA to mobile communication apparatus 20 (step S514).

[0144]

Next, mobile communication apparatus 20 receives the binding acknowledgement message from home agent apparatus 40 through access router apparatus 100c (step S514), and recognizes that the location registration has been completed.

[0145]

From that time onward, same as preferred embodiment 1, mobile communication apparatus 20 continues to forward binding update message 2200 to correspondent node 80 according to the mobile IP procedure (step S415).

[0146]

After receiving binding update message 2200, correspondent node 80 updates the stored binding cache 2300, and optimizes the route. As a result, correspondent node 80 communicates directly with the care-of address, instead of the home address of mobile communication apparatus 20 (step S416). The packet format is not limited to the illustrated example, and any other format may be used as far as the same effects are obtained.

(Mobile communication apparatus)

Operations of the mobile communication apparatus of the preferred

embodiment are explained. In this preferred embodiment, the configuration and basic operations of the mobile communication apparatus are same as explained in preferred embodiment 1, and this preferred embodiment differs in the move from the pre-movement source access router apparatus 100d which does not comply with Fast Mobile IP, and in the point that the mobile communication apparatus applies the Fast Mobile IP procedure in the home agent apparatus.

[0147]

In the operation flowcharts of mobile communication apparatus 20 shown in Fig. 8 and Fig. 9, as a result of processing at step S604, when Fast Mobile IP compliance judging part 27 detects that pre-movement source access router apparatus 100c does not comply with Fast Mobile IP, Fast Mobile IP control part 26 instructs mobile IP/Fast Mobile IP processing part 25 to transmit proxy router solicitation (RtSolPr) message 1400 to the home agent apparatus. Then mobile IP/Fast Mobile IP processing part 25 processes the transmission by way of IP processing part 23 (step S605). Proxy router solicitation message 1400 includes the identifier tag of movement-destination access router apparatus 100c acquired previously. In particular, when the identifier tag is the lower layer address, it is written in new LLA field 1401.

[0148]

As the reply to proxy router solicitation message 1400, when proxy router advertisement message 1500 is received in mobile IP/Fast Mobile IP processing part 25 from home agent apparatus 40 via IP processing part 23 (step S701), same as in the case of preferred embodiment 1, the information

on movement-destination access router apparatus 100c is acquired (step S702).

[0149]

In the preferred embodiment, since proxy router advertisement message 1500 is received from home agent apparatus 40 (step S704), the process of step S705 is executed. That is, it is verified whether the acquired movement-destination access router apparatus 100d complies with Fast Mobile IP or not (step S705).

[0150]

If not complying, same as in preferred embodiment 1, buffering request message 2000 is sent to home agent apparatus (step S706).

[0151]

If complying, Fast Mobile IP control part 26 writes the address of movement-destination access router apparatus 100c (or the IP address of mobile communication apparatus 20 usable when connected to movement-destination access router apparatus 100c) as the IP address of the access router apparatus as the handover destination in replacement care-of address field 1601 of fast binding update message 1600, and instructs mobile IP/Fast Mobile IP processing part 25 to transmit. Receiving this instruction, mobile IP/Fast Mobile IP processing part 25 transmits fast binding update message 1600 to home agent apparatus 40 (step S707).

[0152]

The subsequent process is same as in preferred embodiment 1. As described herein, according to the mobile communication apparatus of the present invention, in a network environment in which the access router

apparatuses which comply with Fast Mobile IP and the access router apparatuses which do not comply with Fast Mobile IP are intermixed, even when the pre-movement source access router does not comply with Fast Mobile IP, same effects as in Fast Mobile IP can be obtained by interposing the home agent apparatus, and the handover efficiency in the mobile communication system can be improved.

(Home agent apparatus)

Next, the configuration and operation of home agent apparatus 40 according to the present invention will be explained with reference to the drawings. In the preferred embodiment, the configuration and basic operations of home agent apparatus are same as explained in preferred embodiment 1, and only different points are explained below.

[0153]

Fig. 18 is a configuration diagram of home agent apparatus 40 according to this preferred embodiment, and what differs from preferred embodiment 1 is that it additionally includes movement-destination access router searching part 48 for acquiring the information on movement-destination access router apparatus 100c as the movement destination of mobile communication apparatus 20.

[0154]

Fig. 19 shows a second configuration of home agent apparatus 40 according to this preferred embodiment, and what differs from Fig. 18 is that it further includes access router information list 50 storing information on the access router apparatuses, and access router information searching part 49. This access router information searching part 49 is connected to

movement-destination access router searching part 48, and searches information on the corresponding access router apparatus from access router information list 50, and forwards to movement-destination access router searching part 48.

[0155]

Operations of home agent apparatus 40 having such configuration are same as explained in Fig. 10 to Fig. 12 relating to preferred embodiment 1.

[0156]

The corresponding operation occurring when home agent apparatus 40 receives specified messages from mobile communication apparatus 20 is explained below by each message received by referring to the accompanying drawing.

[0157]

Fig. 20 is an operation flowchart showing the operation when home agent apparatus 40a receives proxy router solicitation message 1400 transmitted from mobile communication apparatus 20.

[0158]

When IP processing part 43 receives proxy router solicitation message 1400 through lower layer processing part 41 or 42 (step S801), it forwards it to mobile IP/Fast Mobile IP processing part 45, and mobile IP/Fast Mobile IP processing part 45 notifies the identifier tag of movement-destination access router apparatus 100d written in proxy router solicitation message 1400, for example, the lower layer address, to movement-destination access router searching part 48, and request to search

for information on corresponding access router apparatus 100d.

[0159]

In home agent apparatus 40 having the configuration as shown in Fig. 18, movement-destination access router searching part 48 transmits a message requesting information on corresponding access router apparatus 100c to access router information server apparatus 60 through upper layer processing part 44 and IP processing part 43, forwards the replied information on access router apparatus 100c to mobile IP/Fast Mobile IP processing part 45 (step S802).

[0160]

Movement-destination access router searching part 48 of home agent apparatus 40 having the configuration as shown in Fig. 19 issues a search request including the identifier tag of access router apparatus 100d to access router information searching part 49, and access router information searching part 49 searches for the corresponding information from access router information list 50 (step S802). The access router information list is same as explained in preferred embodiment 1.

[0161]

Mobile IP/Fast Mobile IP processing part 45 transmits proxy router advertisement message 1500 including the obtained information to mobile communication apparatus 20 (step S804). If information on corresponding access router apparatus 100c has not been obtained, it is noted in code field 1501, which is transmitted to mobile communication apparatus 20 together with proxy router advertisement message 1500 (step S803).

[0162]

Fig. 21 is an operation flowchart showing the operation when home agent apparatus 40a has received fast binding update message 1600 transmitted from mobile communication apparatus 20.

[0163]

IP processing part 43 receives fast binding update message 1600 through lower layer processing part 41 or 42 (step S1101), and forwards it to mobile IP/Fast Mobile IP processing part 45. Then, mobile IP/Fast Mobile IP processing part 45 transmits handover initiate message 1700 to the IP address written in replacement care-of address field 1601 of fast binding update message 1600, that is, to the IP address of movement-destination access router apparatus 100d (step S1102). After that, the standard Fast Mobile IP procedure is executed.

[0164]

Thus, according to the home agent apparatus of the preferred embodiment, in a network environment in which the access router apparatuses which comply with Fast Mobile IP and the access router apparatuses which do not comply with Fast Mobile IP are intermixed, even when the pre-movement source access router apparatus connected when the mobile communication moves does not comply with Fast Mobile IP, the home agent apparatus acts for the movement-destination access router apparatus and executes the Fast Mobile IP procedure, and packet loss can be eliminated in the same way as in Fast Mobile IP.

[0165]

As described herein, according to the preferred embodiment, in a network environment in which the access router apparatuses which comply

with Fast Mobile IP and the access router apparatuses which do not comply with Fast Mobile IP are intermixed, the mobile communication apparatus checks whether the pre-movement source access router apparatus and the movement-destination access router comply with Fast Mobile IP or not, and even when the movement-destination router does not comply with Fast Mobile IP, the mobile communication apparatus specifies the home agent apparatus as the substitute for the movement-destination access router apparatus and executes the Fast Mobile IP procedure, and handover with packet loss can be realized, and when both access router apparatuses comply with Fast Mobile IP, the Fast Mobile IP can be executed mutually, and the forwarding efficiency is enhanced at the time of handover.

[Industrial Application]

[0166]

The present invention is very useful when applied in the case where the mobile communication apparatus moves between different sub-networks, and is applicable if the pre-movement source access router apparatus or movement-destination access route apparatus does not comply with Fast Mobile IP.

[Brief Description of the Drawings]

[0167]

Fig. 1 is a configuration diagram of a mobile communication system in preferred embodiment 1 of the present invention.

Fig. 2 is a configuration diagram of a mobile communication apparatus in preferred embodiment 1 of the present invention.

Fig. 3 is a configuration diagram of a home agent apparatus in preferred embodiment 1 of the present invention.

Fig. 4 is a data configuration diagram of a binding cache in preferred embodiment 1 of the present invention.

Fig. 5 is a configuration diagram of an access router information server apparatus in preferred embodiment 1 of the present invention.

Fig. 6 is a first sequence diagram of operation of the mobile communication system in preferred embodiment 1 of the present invention.

Fig. 7 is a second sequence diagram of operation of the mobile communication system in preferred embodiment 1 of the present invention.

Fig. 8 is flowchart of first operation of the mobile communication apparatus in preferred embodiment 1 of the present invention.

Fig. 9 is flowchart of second operation of the mobile communication apparatus in preferred embodiment 1 of the present invention.

Fig. 10 is flowchart of first operation of the home agent apparatus in preferred embodiment 1 of the present invention.

Fig. 11 is flowchart of second operation of the home agent apparatus in preferred embodiment 1 of the present invention.

Fig. 12 is flowchart of third operation of the home agent apparatus in preferred embodiment 1 of the present invention.

Fig. 13 is flowchart of operation of an access router information server apparatus in preferred embodiment 1 of the present invention.

Fig. 14 (a) is a first configuration diagram of access router apparatus information list in preferred embodiment 1 of the present invention, (b) is a second configuration diagram of access router apparatus information list in

preferred embodiment 1 of the present invention, and (c) is a third configuration diagram of access router apparatus information list in preferred embodiment 1 of the present invention.

Fig. 15 is a configuration diagram of a mobile communication system in preferred embodiment 2 of the present invention.

Fig. 16 is a first sequence diagram of operation of the mobile communication system in preferred embodiment 2 of the present invention.

Fig. 17 is a second sequence diagram of operation of the mobile communication system in preferred embodiment 2 of the present invention.

Fig. 18 is a first configuration diagram of a home agent apparatus in preferred embodiment 2 of the present invention.

Fig. 19 is a second configuration diagram of the home agent apparatus in preferred embodiment 2 of the present invention.

Fig. 20 is flowchart of first operation of the home agent apparatus in preferred embodiment 2 of the present invention.

Fig. 21 is flowchart of second operation of the home agent apparatus in preferred embodiment 2 of the present invention.

Fig. 22 is a format diagram of router advertisement message in preferred embodiment 1 of the present invention.

Fig. 23 is a format diagram of fast binding acknowledgement message in preferred embodiment 1 of the present invention.

Fig. 24 is a format diagram of buffering request message in preferred embodiment 1 of the present invention.

Fig. 25 is a format diagram of buffering reply message in preferred embodiment 1 of the present invention.

Fig. 26 is a format diagram of binding update message in preferred embodiment 1 of the present invention.

Fig. 27 is a format diagram of proxy router solicitation message in preferred embodiment 1 of the present invention.

Fig. 28 is a format diagram of proxy router advertisement message in preferred embodiment 1 of the present invention.

Fig. 29 is a format diagram of fast binding update message in preferred embodiment 1 of the present invention.

Fig. 30 is a format diagram of inquiry message in preferred embodiment 1 of the present invention.

Fig. 31 is a format diagram of reply message in preferred embodiment 1 of the present invention.

Fig. 32 is a format diagram of handover initiate message in preferred embodiment 1 of the present invention.

Fig. 33 is a format diagram of handover acknowledgement message in preferred embodiment 1 of the present invention.

Fig. 34 is a sequence diagram of operation of a conventional mobile communication system.

[Description of the Reference Numerals and Signs]

[0168]

1 Internet

10, 11 Local network

20 Mobile communication apparatus

40, 40a, 40b Home agent apparatus

60 Access router information server apparatus

80 Correspondent node

100a to 100f Access router apparatus

21, 22 Lower layer processing part

23 IP processing part

24 Upper layer processing part

25 Mobile IP/Fast Mobile IP processing part

26 Fast Mobile IP control part

27 Fast Mobile IP compliance determining part

28 Access router searching part

41, 42 Lower layer processing part

43 IP processing part

44 Upper layer processing part

45 Mobile IP/Fast Mobile IP processing part

46 Buffer management part

47 Buffer memory

48 Movement-destination access router searching part

49 Access router information searching part

50 Access router information list

61, 62 Lower layer processing part

63 IP processing part

64 Upper layer processing part

65 Access router information list

66 Access router information searching part

67 Access router information notifying part

[Name of the Document] Abstract

[Abstract]

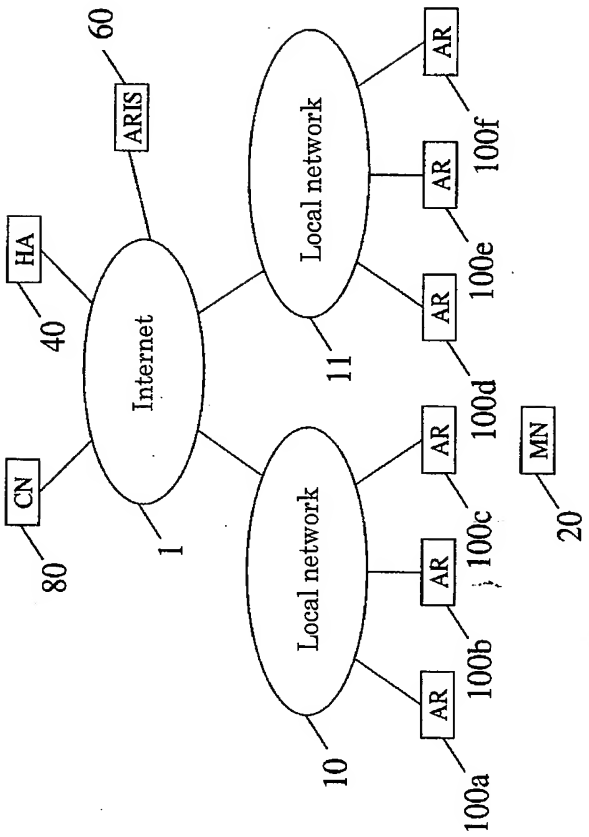
[Object] To present a mobile communication method in which Fast Mobile IP can be applied if an access router apparatus does not comply with Fast Mobile IP.

[Means to Solve the Problems] Mobile communication apparatus 20 includes mobile IP/Fast Mobile IP processing part 25, access router searching part 28 for acquiring information on access router apparatuses, Fast Mobile IP compliance determining part 27 for determining whether access router apparatuses comply with Fast Mobile IP or not, and Fast Mobile IP control part 26 for controlling the content of the message generated by mobile IP/Fast Mobile IP processing part 25, in which a Fast Mobile IP procedure can be executed if any one of access routers does not comply with Fast Mobile IP, so that the packet loss can be eliminated.

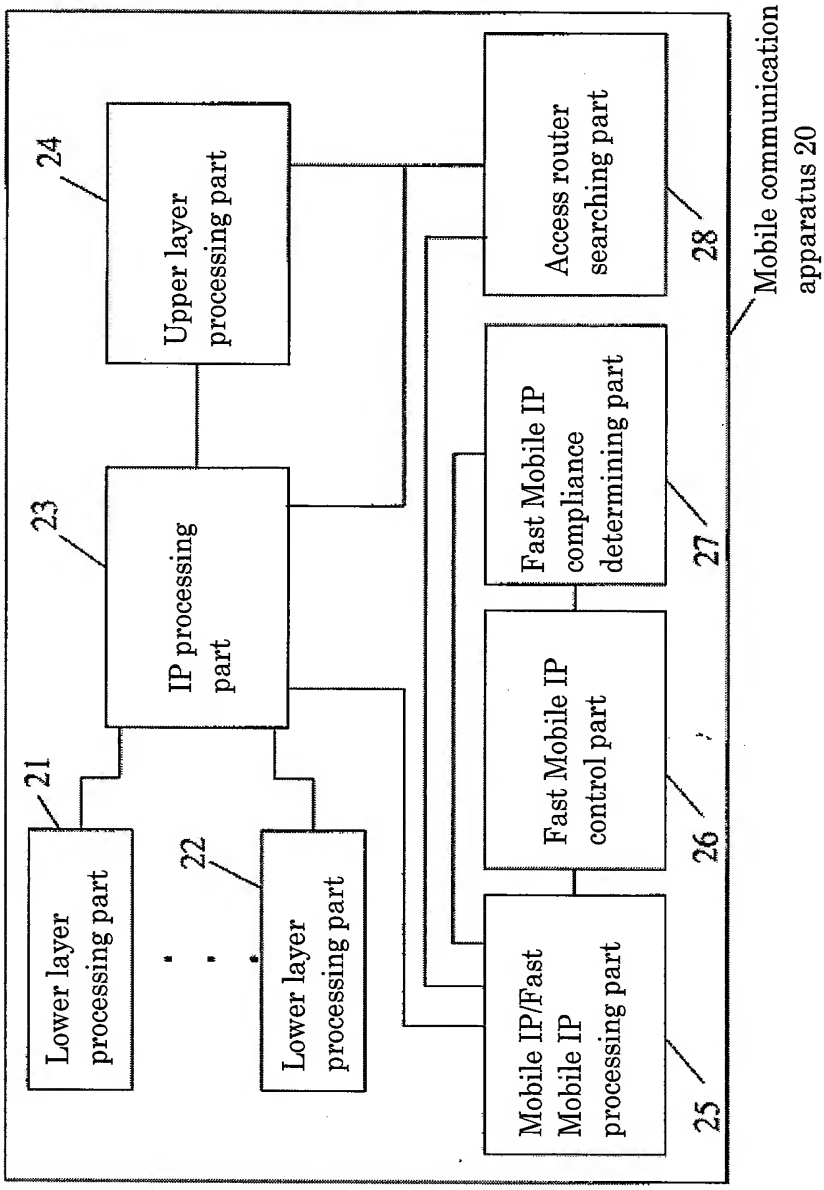
[Selected Drawing] Fig. 2

[Name of the Document] Drawing

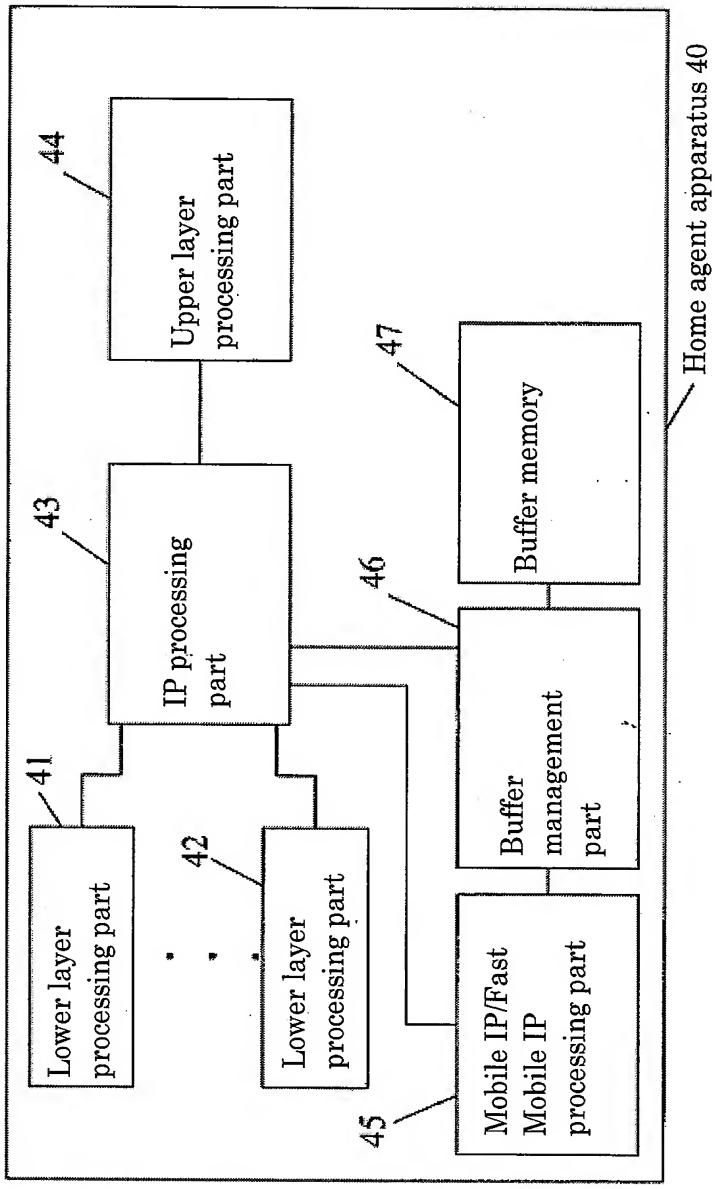
[Fig. 1]



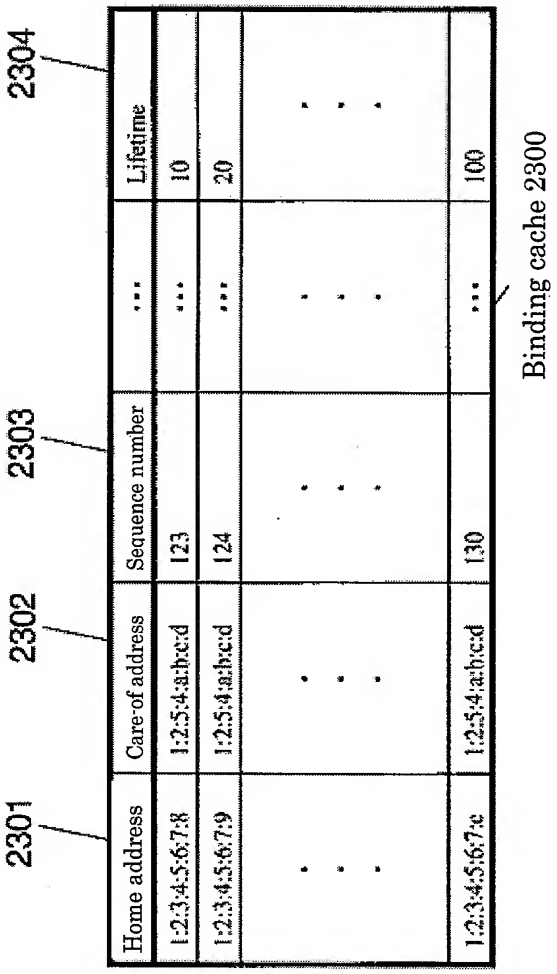
[Fig. 2]


Mobile communication apparatus 20
Lower layer processing part
21
22
Lower layer processing part
IP processing part
23
Upper layer processing part
24
Mobile IP/Fast Mobile IP processing part
25
Fast Mobile IP control part
26
Fast Mobile IP compliance determining part
27
Access router searching part
28

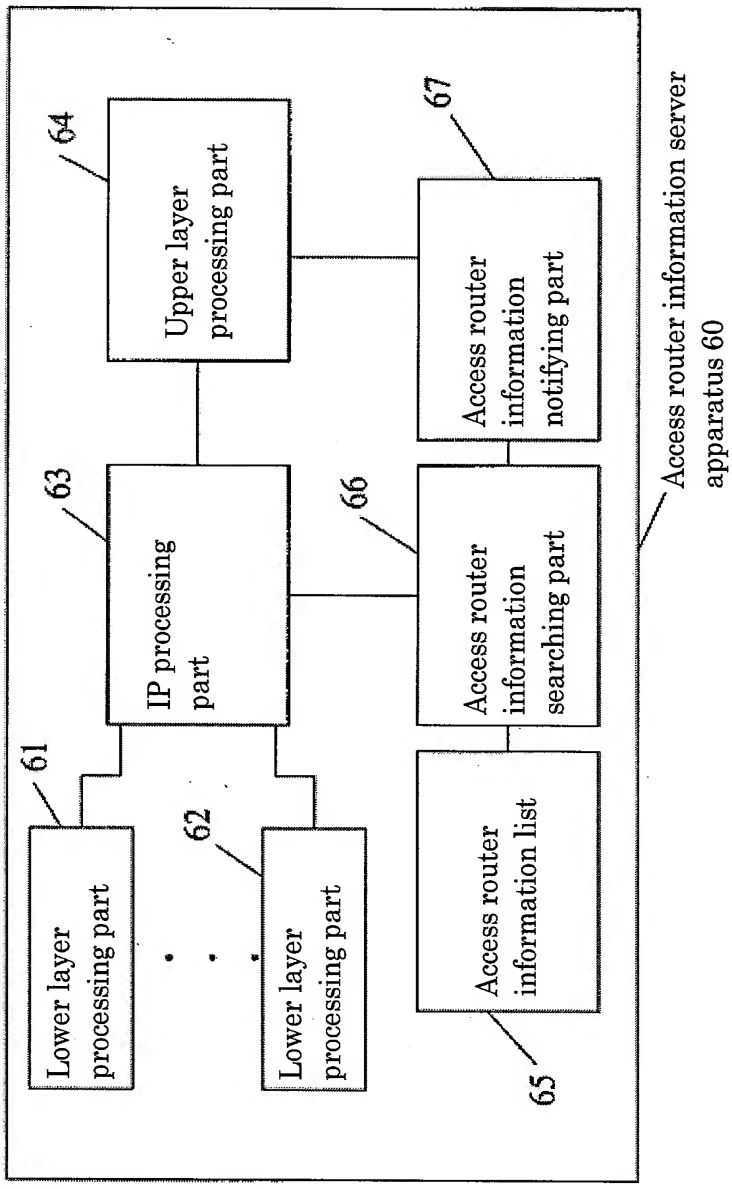
[Fig. 3]


Home agent apparatus 40
Upper layer processing part
44
IP processing part
43
Lower layer processing part
41
Lower layer processing part
42
Buffer memory
47
Buffer management part
46
Mobile IP/Fast Mobile IP processing part
45

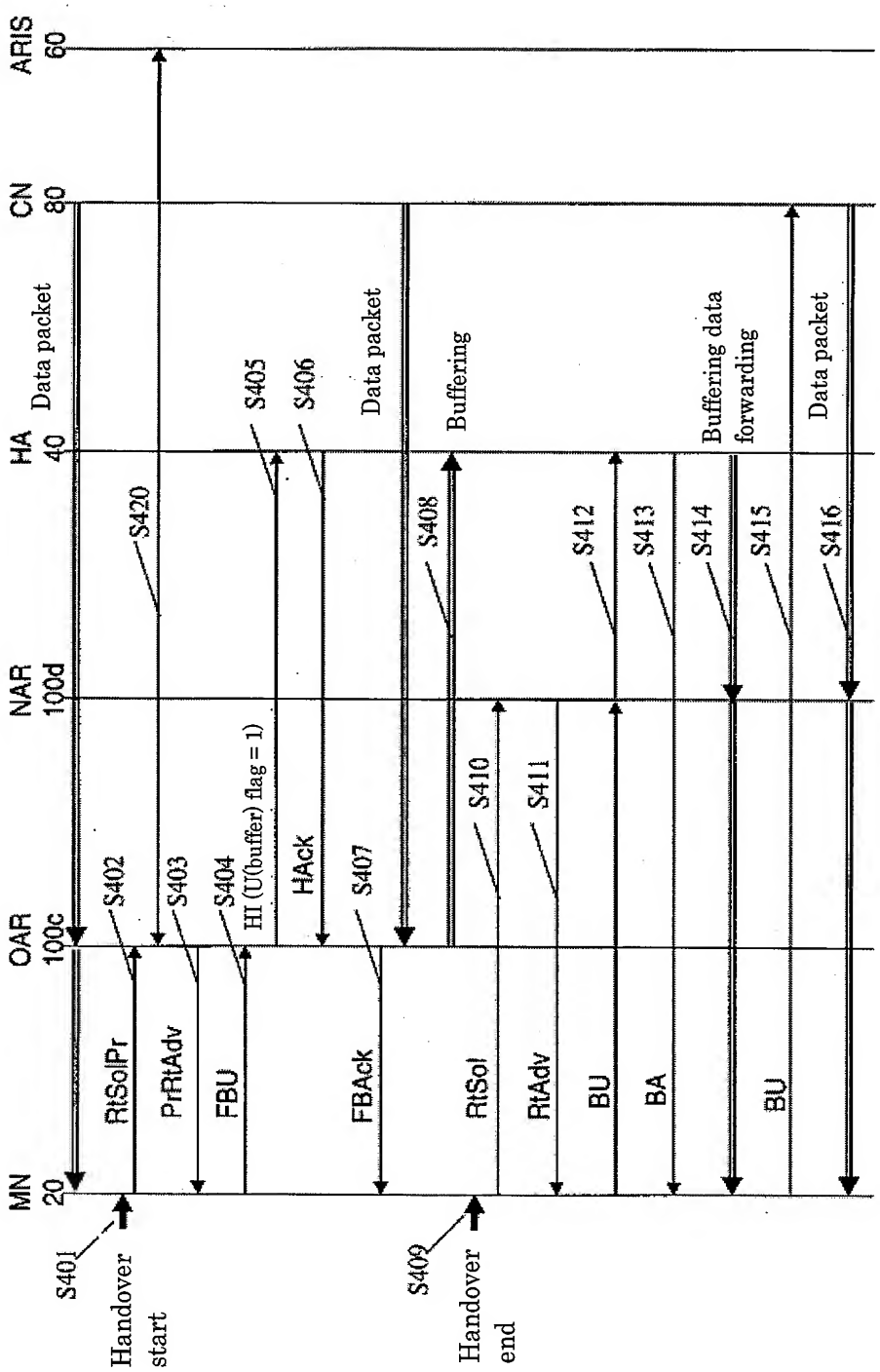
[Fig. 4]


2301
2302
2303
2304
Home address
Care-of address
Sequence number
...
Lifetime
1:2:3:4:5:6:7:8
1:2:5:4:a:b:c:d
123
...
10
1:2:3:4:5:6:7:9
1:2:5:4:a:b:c:d
124
...
20
1:2:3:4:5:6:7:e
1:2:5:4:a:b:c:d
130
...
100
Binding cache 2300

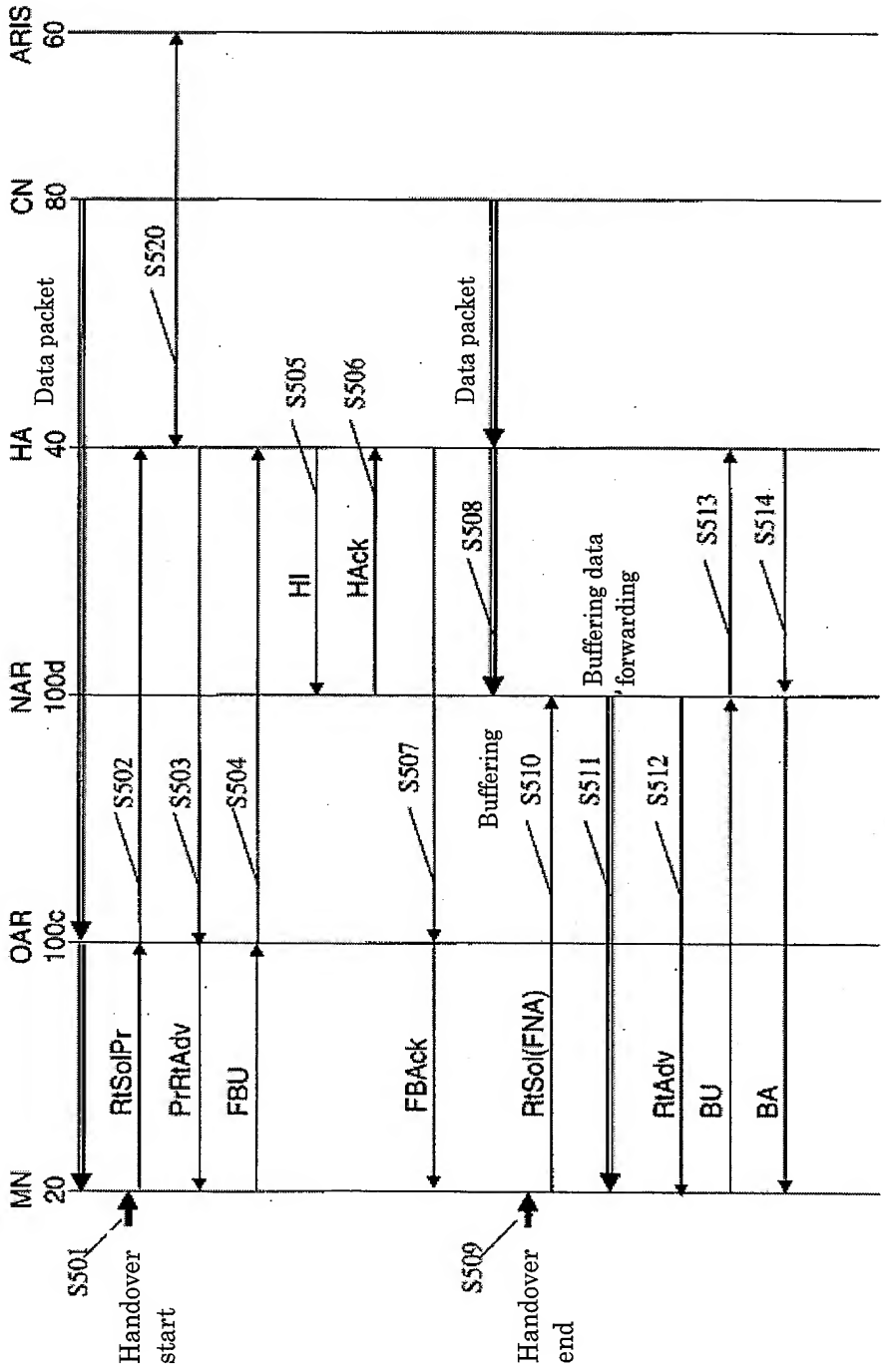
[Fig. 5]


Access router information server apparatus 60
Upper layer processing part
64
IP processing part
63
Lower layer processing part
61
Lower layer processing part
62
Access router information searching part
66
Access router information notifying part
67
Access router information list
65

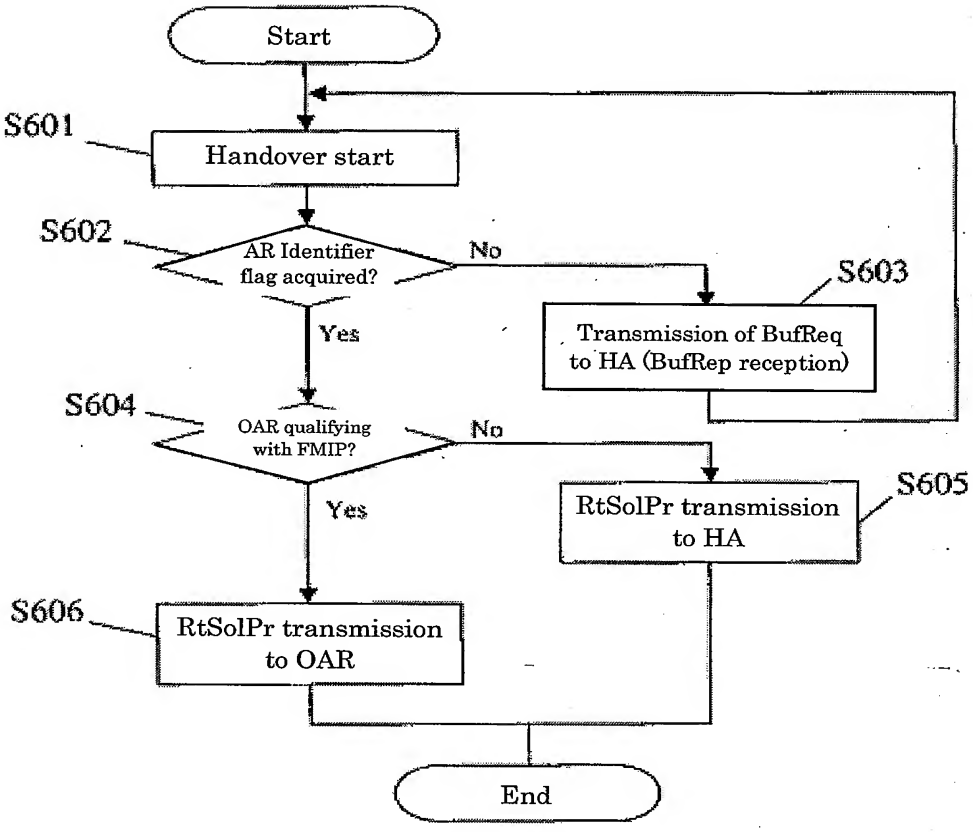
[Fig. 6]


MN 20
OAR 100c
NAR 100d
HA 40
CN 80
ARIS 60
S401
Handover start
RtSolPr
PrRtAdv
FBU
HI (U(buffer) flag = 1)
HAck
FBAck
S402
S403
S404
S405
S406
S407
S408
S409
Handover end
RtSol
RtAdv
BU
BA
BU
S410
S411
S412
S413
S414
S415
S416
S420
Data packet
Data packet
Buffering
Buffering data forwarding
Data packet

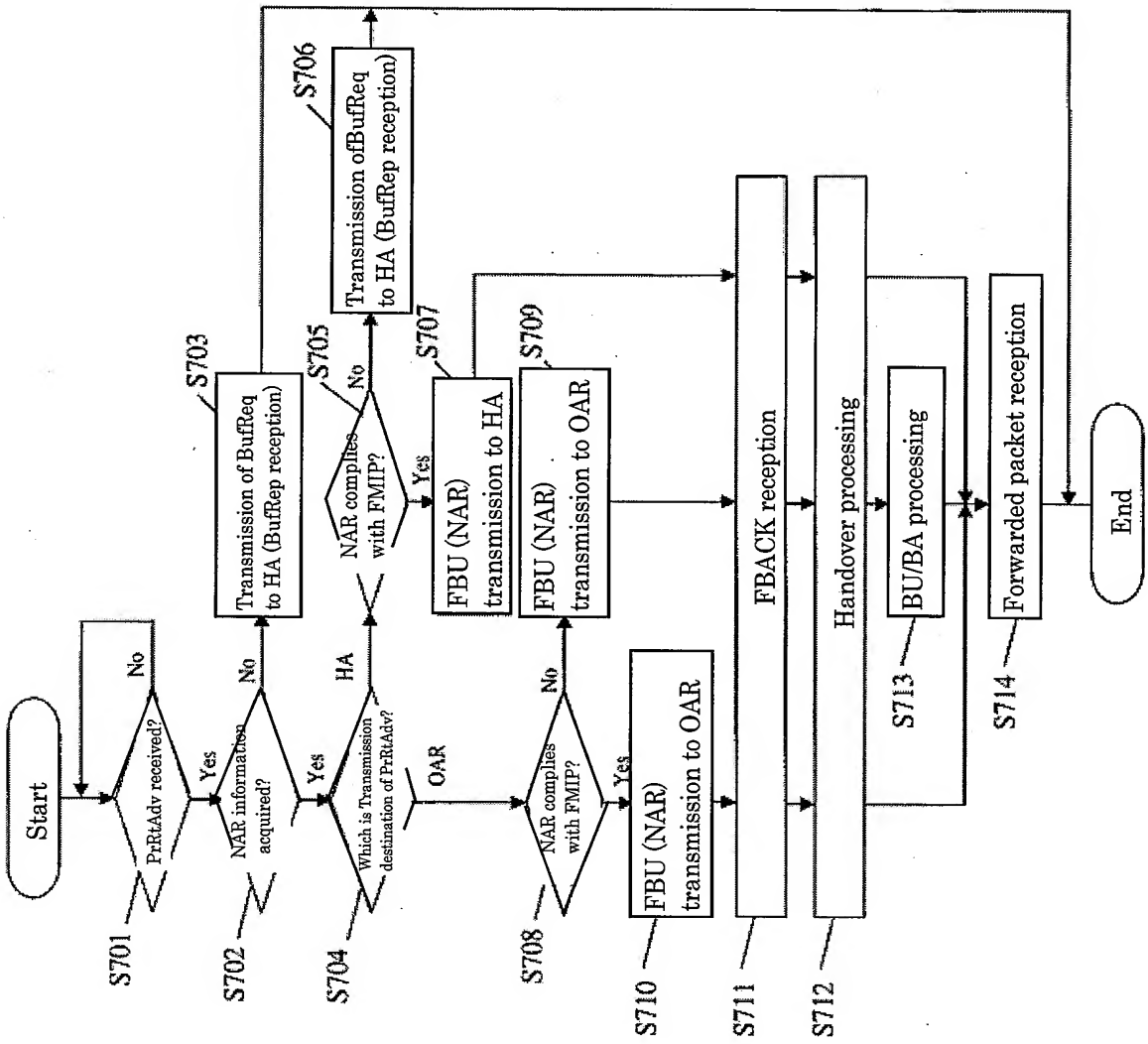
[Fig. 7]


MN 20
OAR 100c
NAR 100d
HA 40
CN 80
ARIS 60
S501
Handover start
RtSolPr
PrRtAdv
FBU
FBAck
RtSol(FNA)
S509
Handover end
S502
S503
S504
S505
S506
S507
S508
S510
S511
S512
S513
S514
S520
HI
HAck
Data packet
Data packet
Buffering
Buffering data forwarding
RtAdv
BU
BA

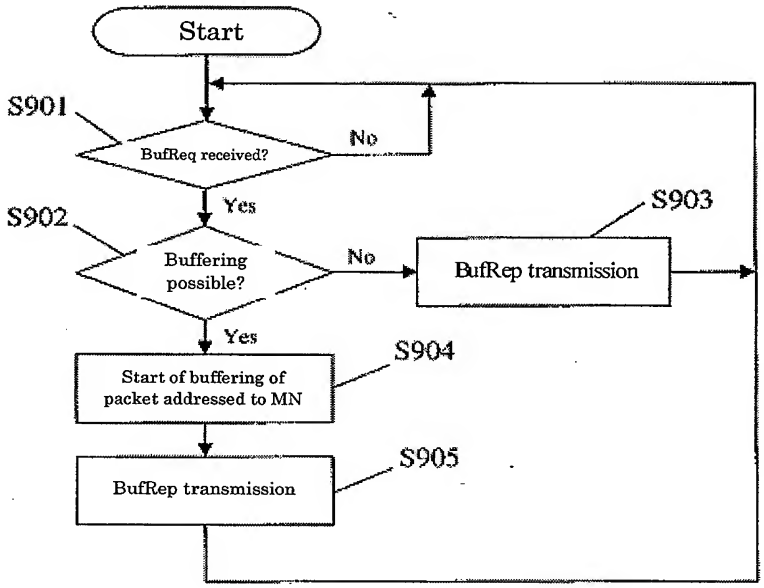
[Fig. 8]


Start
S601
Handover start
S602
AR Identifier flag acquired?
No
S603
Transmission of BufReq to HA (BufRep reception)
Yes
S604
OAR qualifying with FMIP?
No
S605
RtSolPr transmission to HA
Yes
S606
RtSolPr transmission to OAR
End

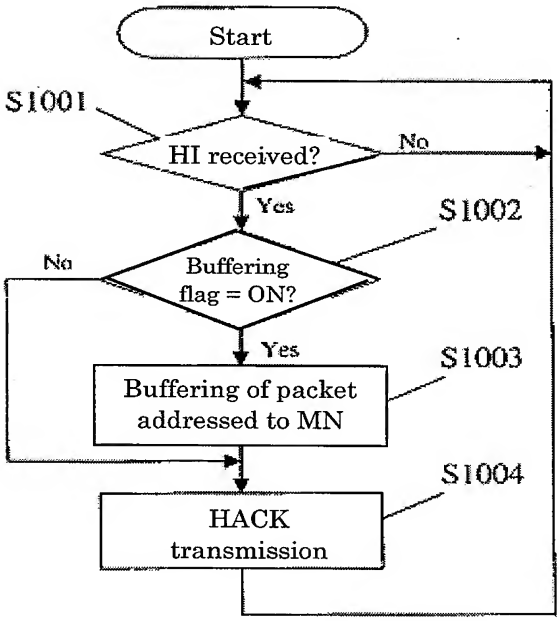
[Fig. 9]


Start
PrRtAdv received?
No
Yes
S701
NAR information acquired?
No
Yes
S702
Which is Transmission destination of PrRtAdv?
HA
OAR
S704
Transmission of BufReq to HA (BufRep reception)
S703
NAR complies with FMIP?
No
Yes
S705
Transmission ofBufReq to HA (BufRep reception)
S706
FBU (NAR) transmission to HA
S707
NAR complies with FMIP?
No
Yes
S708
FBU (NAR) transmission to OAR
S709
FBU (NAR) transmission to OAR
S710
FBACK reception
S711
Handover processing
S712
BU/BA processing
S713
Forwarded packet reception
S714
End

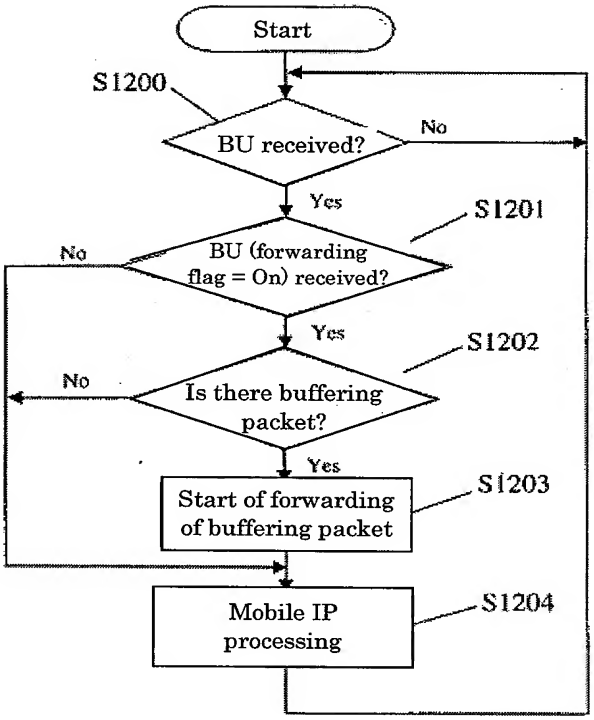
[Fig. 10]


Start
S901
BufReq received?
No
Yes
S902
Buffering possible?
No
S903
BufRep transmission
Yes
S904
Start of buffering of packet addressed to MN
S905
BufRep transmission

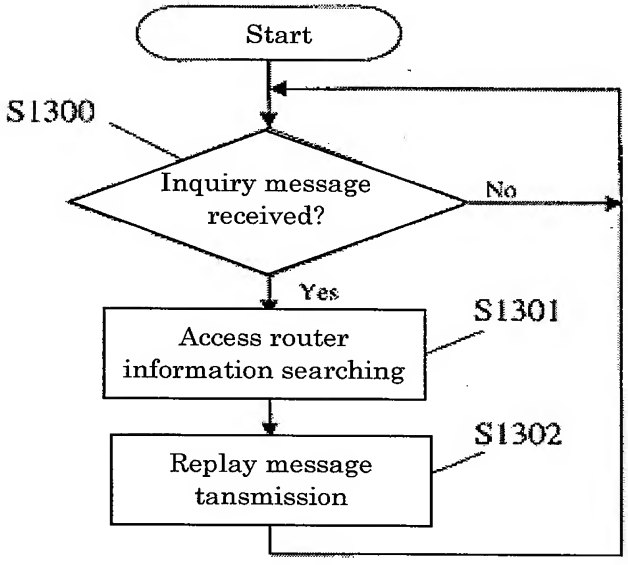
[Fig. 11]


Start
S1001
HI received?
No
Yes
S1002
No
Buffering flag = ON?
Yes
S1003
Buffering of packet addressed to MN
S1004
HACK transmission

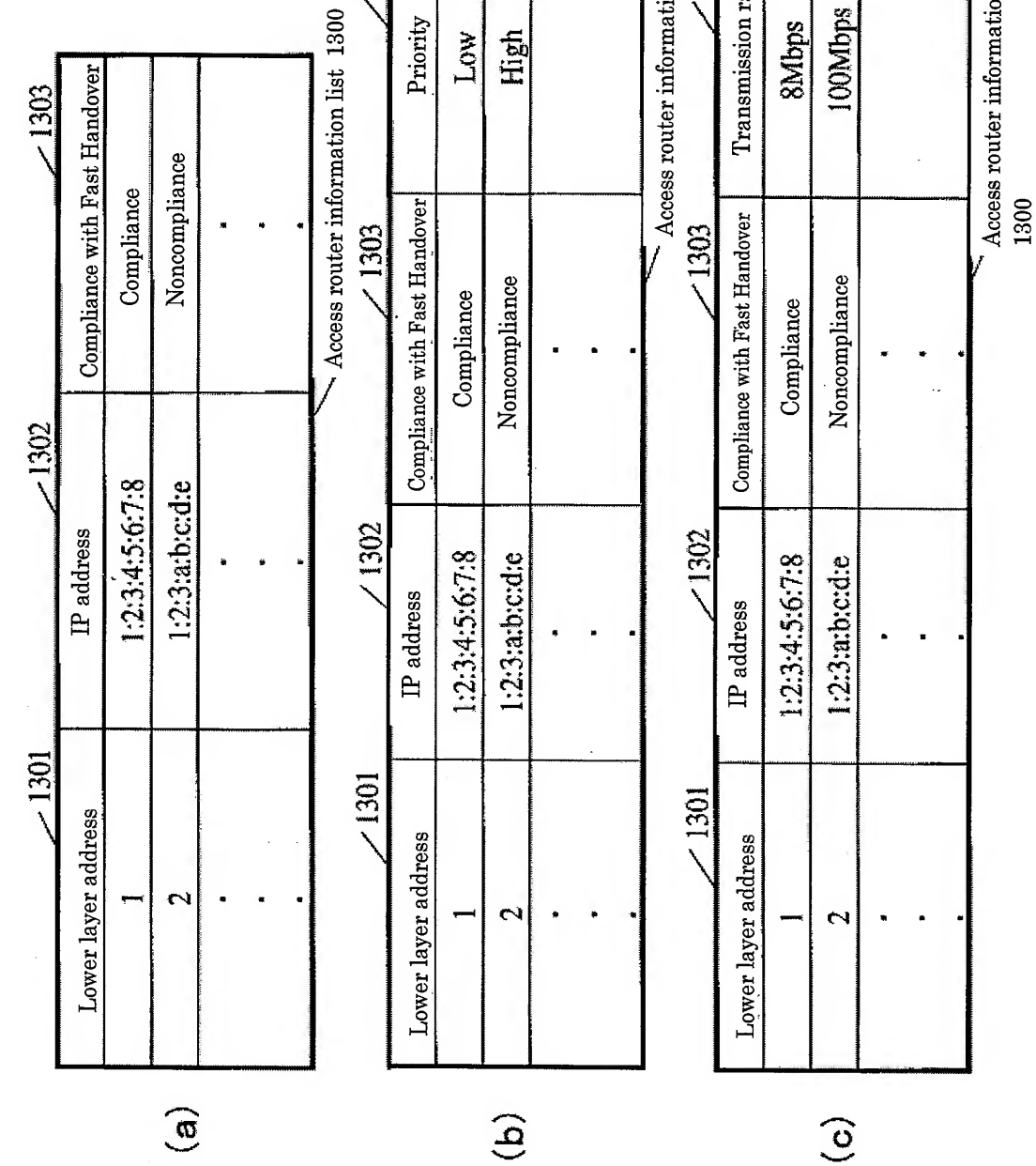
[Fig. 12]


Start
S1200
BU received?
No
Yes
S1201
BU (forwarding flag = On) received?
No
Yes
S1202
Is there buffering packet?
No
Yes
S1203
Start of forwarding of buffering packet
Mobile IP processing
S1204

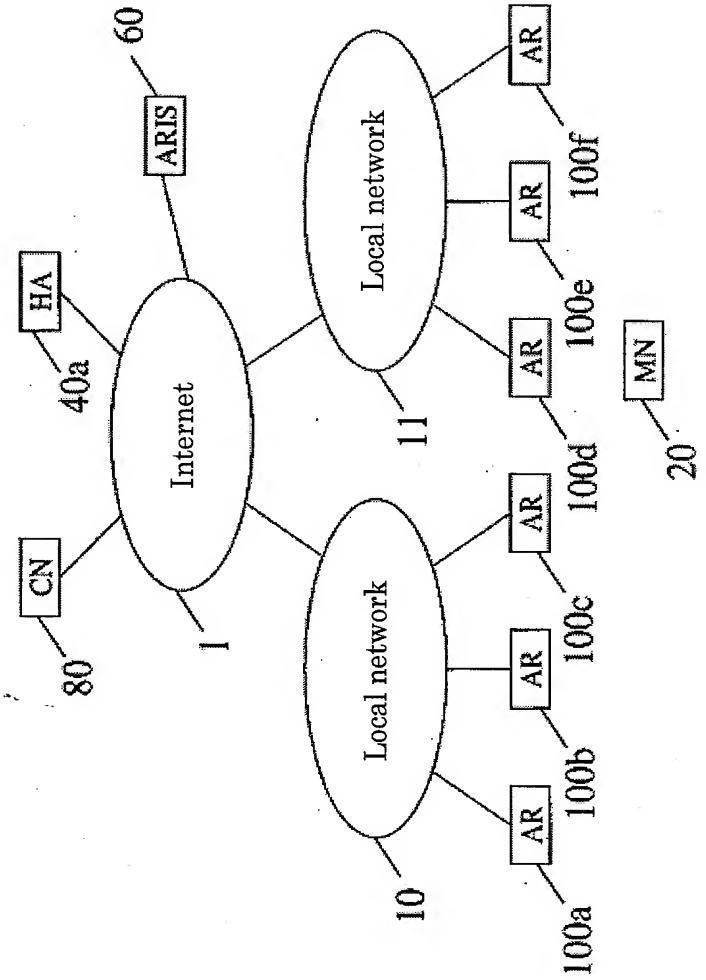
[Fig. 13]


Start
S1300
Inquiry message received?
No
Yes
S1301
Access router information searching
S1302
Replay message tansmission

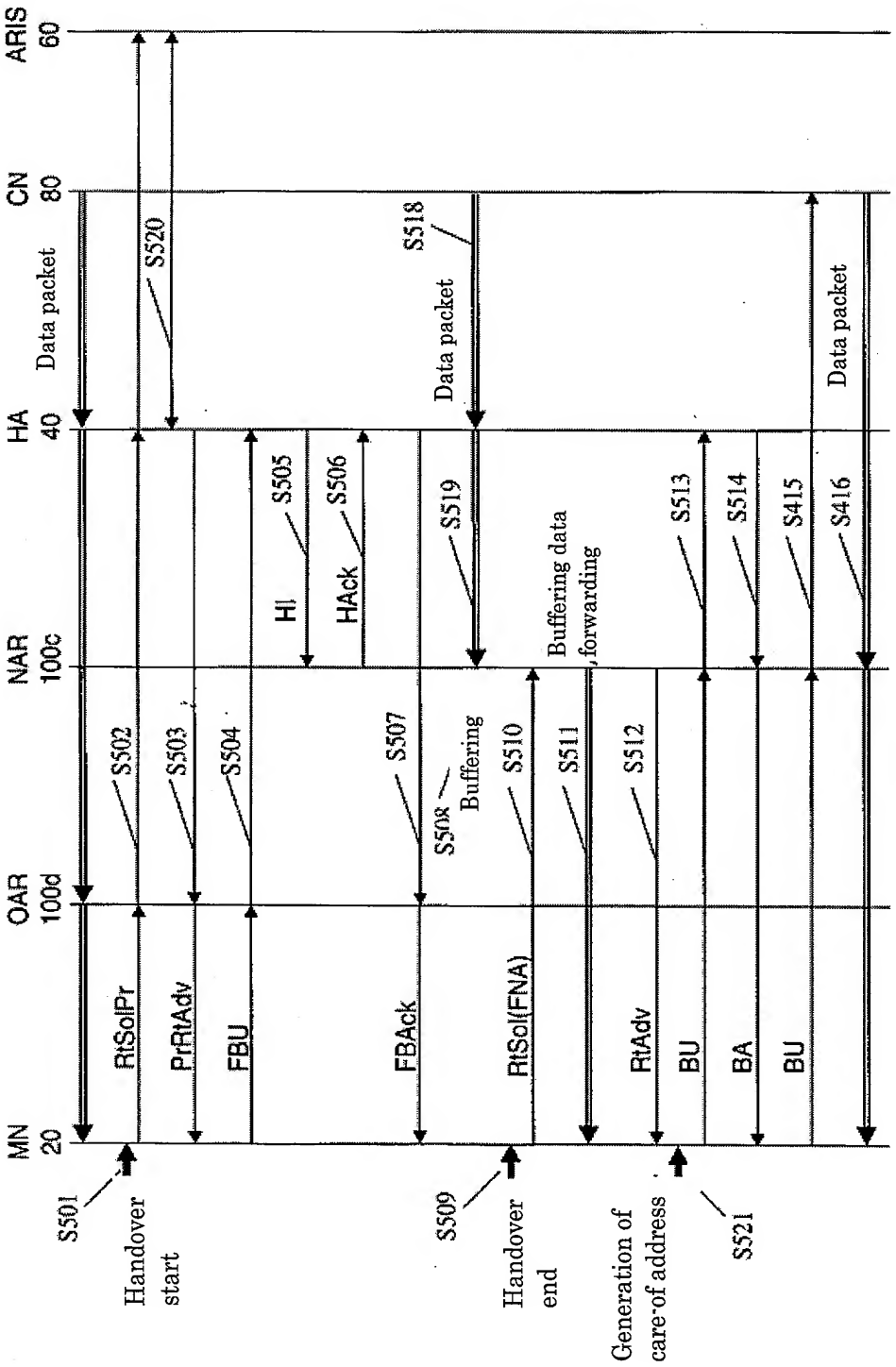
[Fig. 14]


(a)
1301
1302
1303
Lower layer address
IP address
Compliance with Fast Handover
1
1:2:3:4:5:6:7:8
Compliance
2
1:2:3:a:b:c:d:e
Noncompliance
Access router information list 1300
(b)
1301
1302
1303
1304
Lower layer address
IP address
Compliance with Fast Handover
Priority
1
1:2:3:4:5:6:7:8
Compliance
Low
2
1:2:3:a:b:c:d:e
Noncompliance
High
Access router information list
(c)
1301
1302
1303
1305
Lower layer address
IP address
Compliance with Fast Handover
Transmission rate
1
1:2:3:4:5:6:7:8
Compliance
8Mbps
2
1:2:3:a:b:c:d:e
Noncompliance
100Mbps
Access router information list
1300

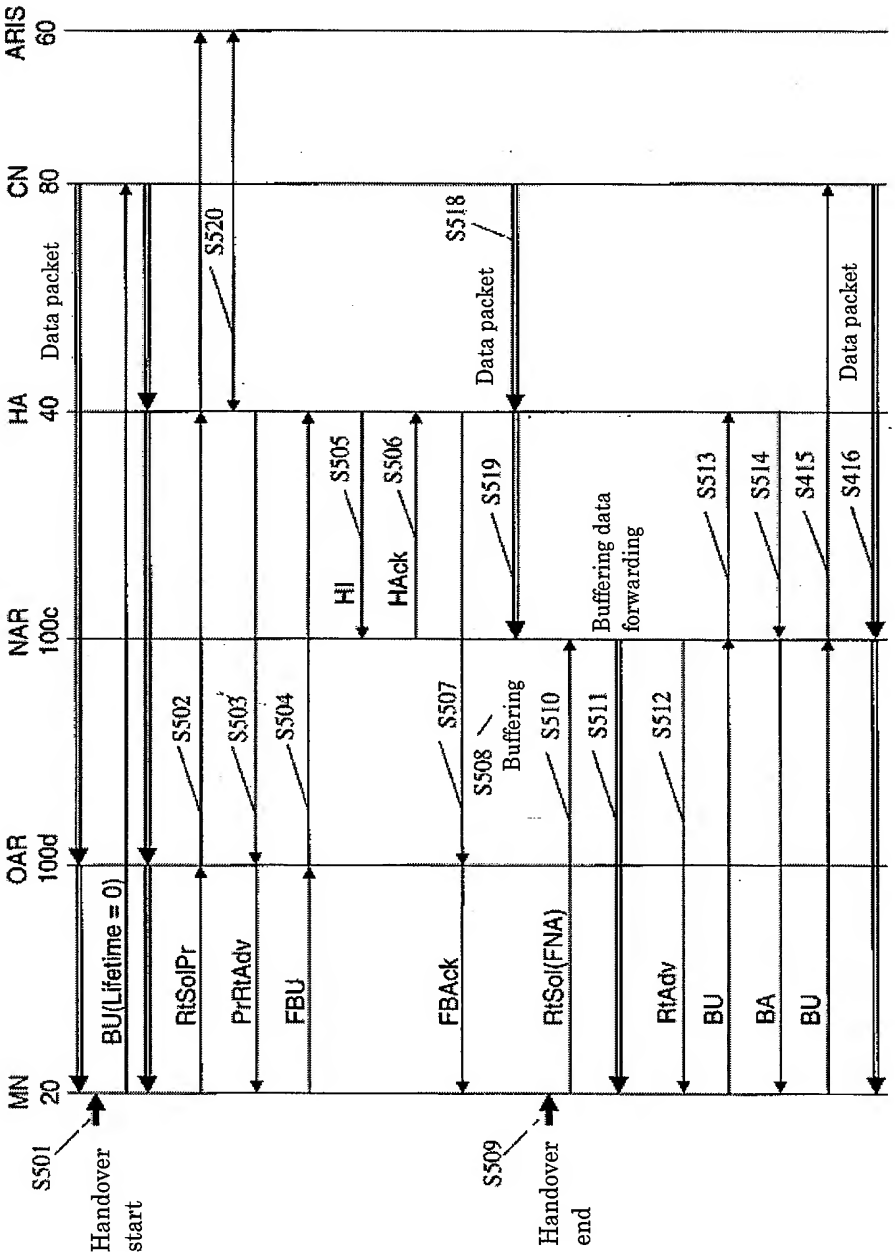
[Fig. 15]


60
ARIS
HA
40a
CN
80
Internet
1
Local network
11
Local network
10
AR
100a
AR
100b
AR
100c
AR
100d
AR
100e
AR
100f
MN
20

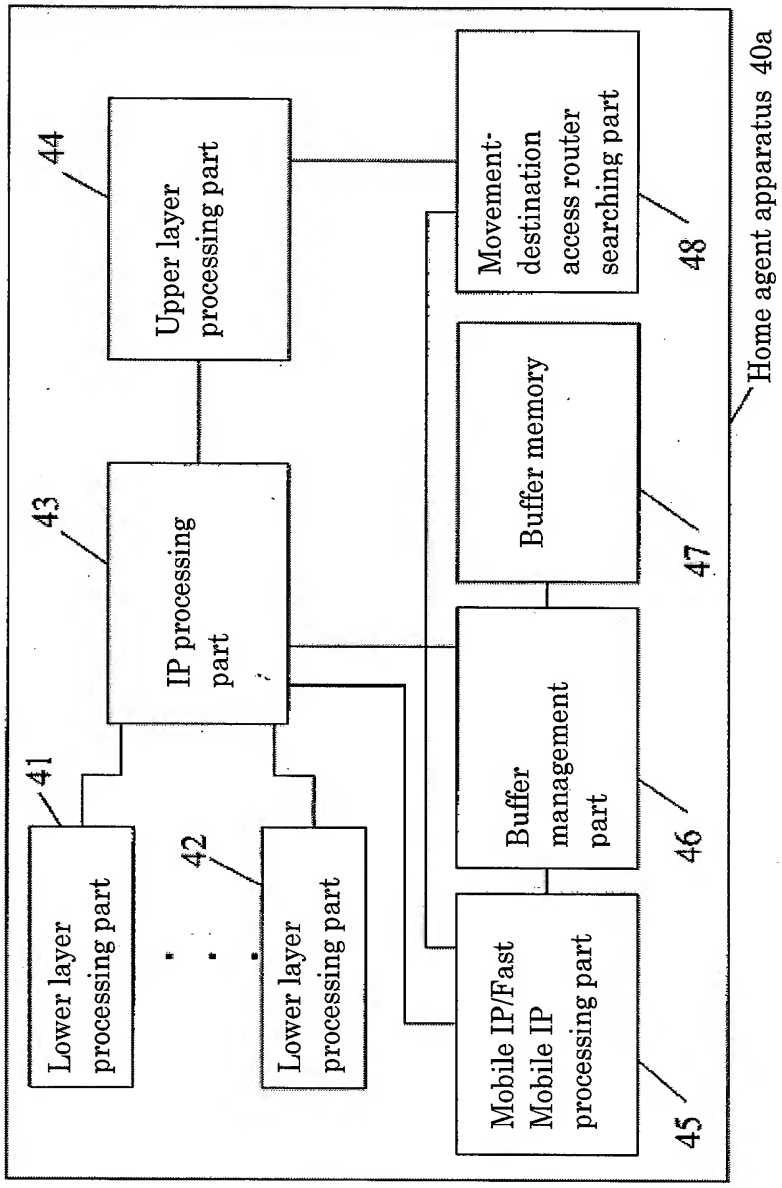
[Fig. 16]


MN 20
OAR 100d
NAR 100c
HA 40
CN 80
ARIS 60
S501
Handover start
RtSolPr
PrRtAdv
FBU
FBAck
S502
S503
S504
S505
S506
S507
S508
Buffering
S509
Handover end
RtSol(FNA)
S510
S511
S512
RtAdv
BU
BA
BU
S513
S514
S415
S416
Generation of care-of address
S521
HI
HAck
S519
Buffering data forwarding
S518
Data packet
S520
Data packet
Data packet

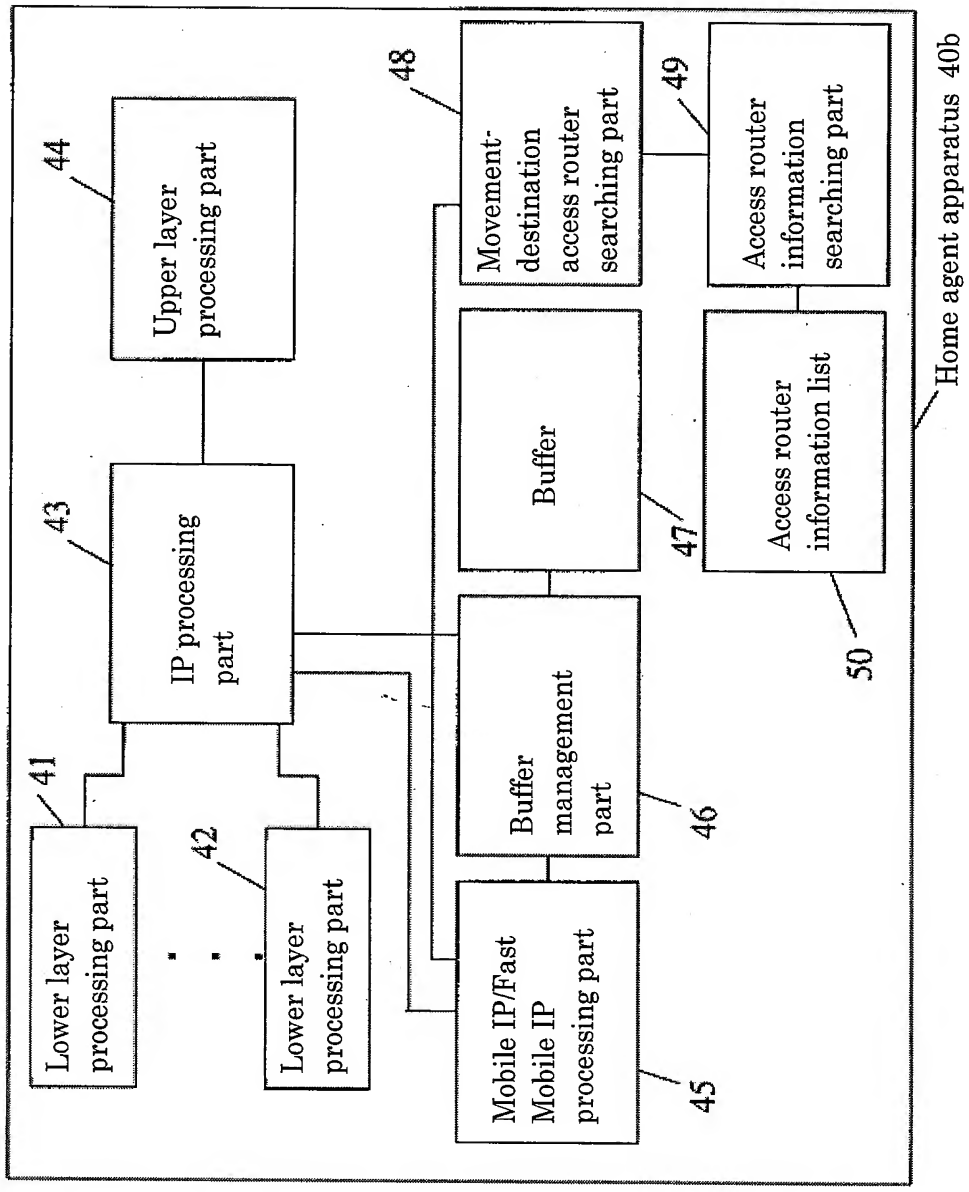
[Fig. 17]


ARIS
60
CN
80
HA
40
NAR
100c
OAR
100d
MN
20
Data packet
BU(Lifetime = 0)
RtSolPr
PrRtAdv
FBU
FBAck
RtSol(FNA)
RtAdv
BU
BA
BU
HI
HAck
Buffering
Buffering data forwarding
S501
Handover start
S502
S503
S504
S505
S506
S507
S508
S509
Handover end
S510
S511
S512
S513
S514
S415
S416
S518
S519
S520
Data packet
Data packet

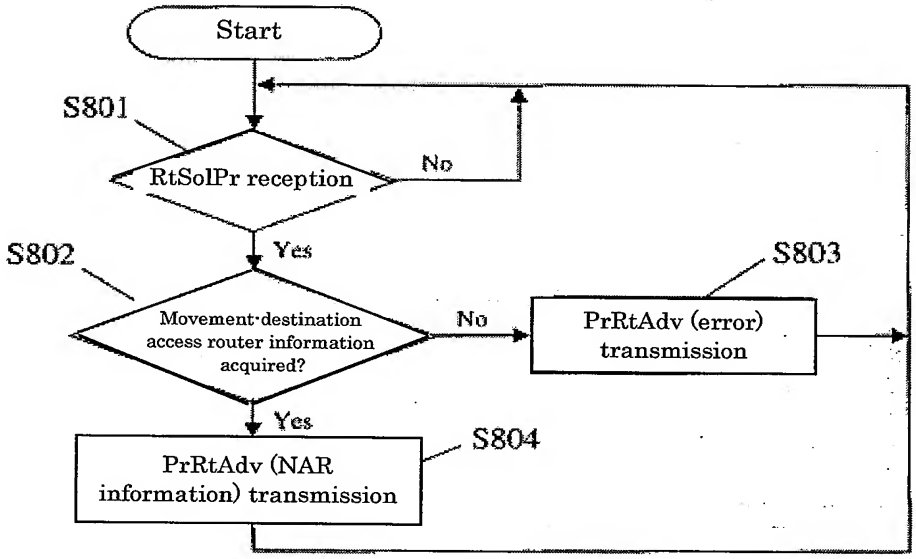
[Fig. 18]


Home agent apparatus 40a
Lower layer processing part
41
Lower layer processing part
42
IP processing part
43
Upper layer processing part
44
Mobile IP/Fast Mobile IP processing part
45
Buffer management part
46
Buffer memory
47
Movement-destination access router searching part
48

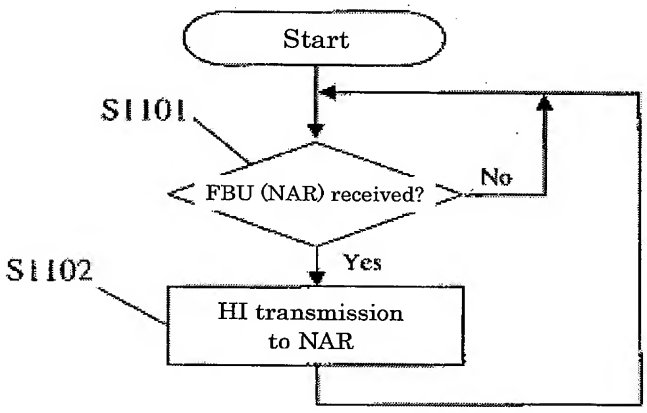
[Fig. 19]


Home agent apparatus 40b
Lower layer processing part
41
Lower layer processing part
42
IP processing part
43
Upper layer processing part
44
Mobile IP/Fast Mobile IP processing part
45
Buffer management part
46
Buffer
47
Movement-destination access router searching part
48
Access router information searching part
49
Access router information list
50

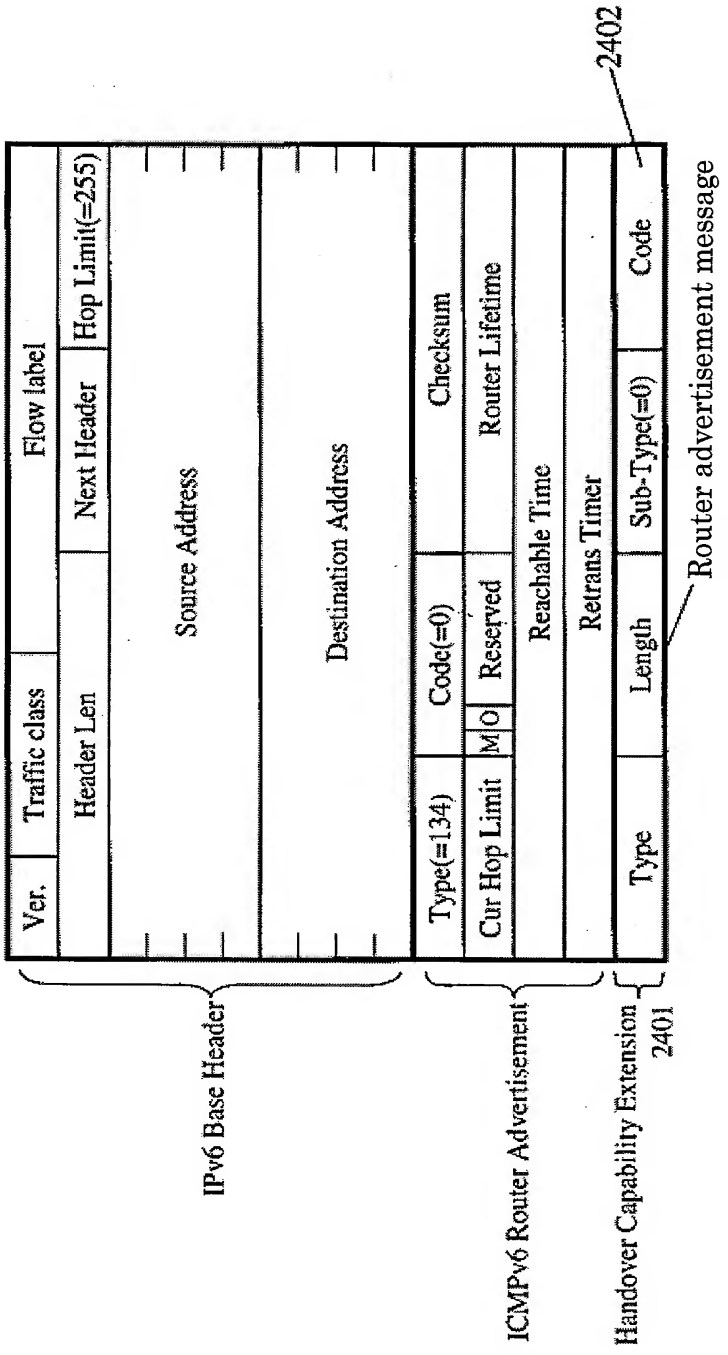
[Fig. 20]


Start
S801
RtSolPr reception
No
Yes
S802
Movement-destination access router information acquired?
No
S803
PrRtAdv (error) transmission
Yes
S804
PrRtAdv (NAR information) transmission

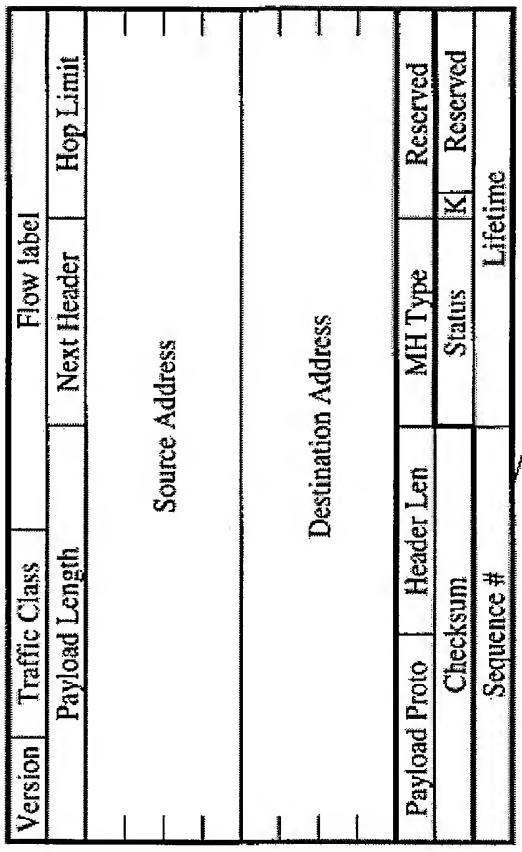
[Fig. 21]


Start
S1101
FBU (NAR) received?
No
Yes
S1102
HI transmission to NAR

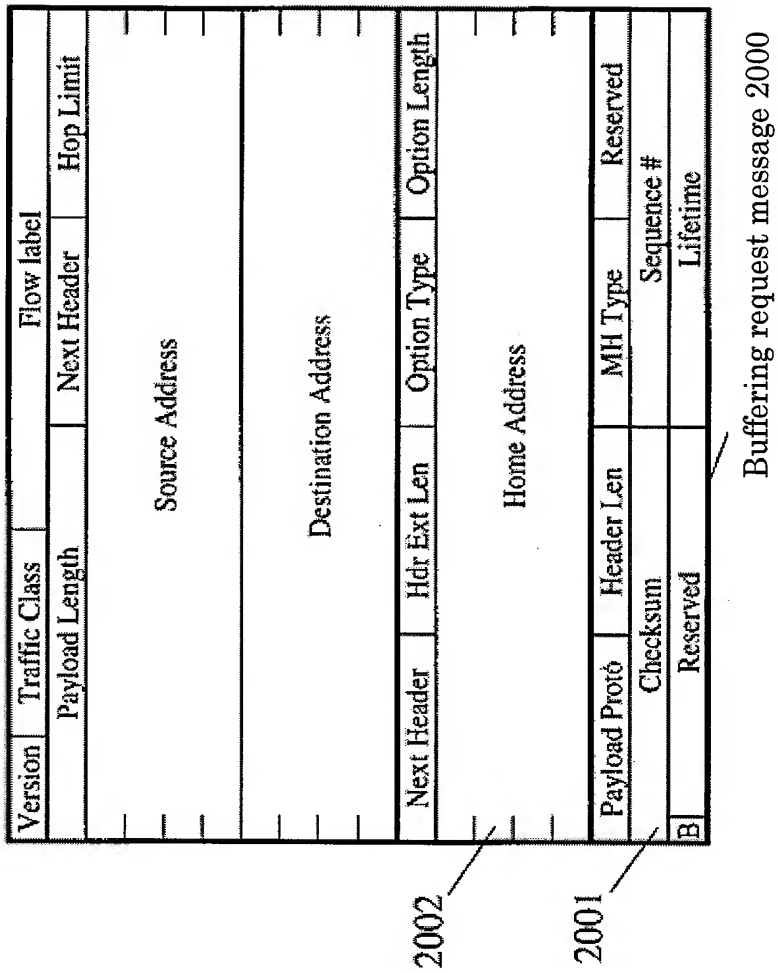
[Fig. 22]


Ver.
Traffic class
Flow label
Header Len
Next Header
Hop Limit(=255)
Source Address
Destination Address
IPv6 Base Header
Type(=134)
Code(=0)
Checksum
Cur Hop Limit
M
O
Reserved
Router Lifetime
Reachable Time
Retrans Timer
ICMPv6 Router Advertisement
Type
Length
Sub-Type(=0)
Code
Handover Capability Extension
2401
2402
Router advertisement message
2400

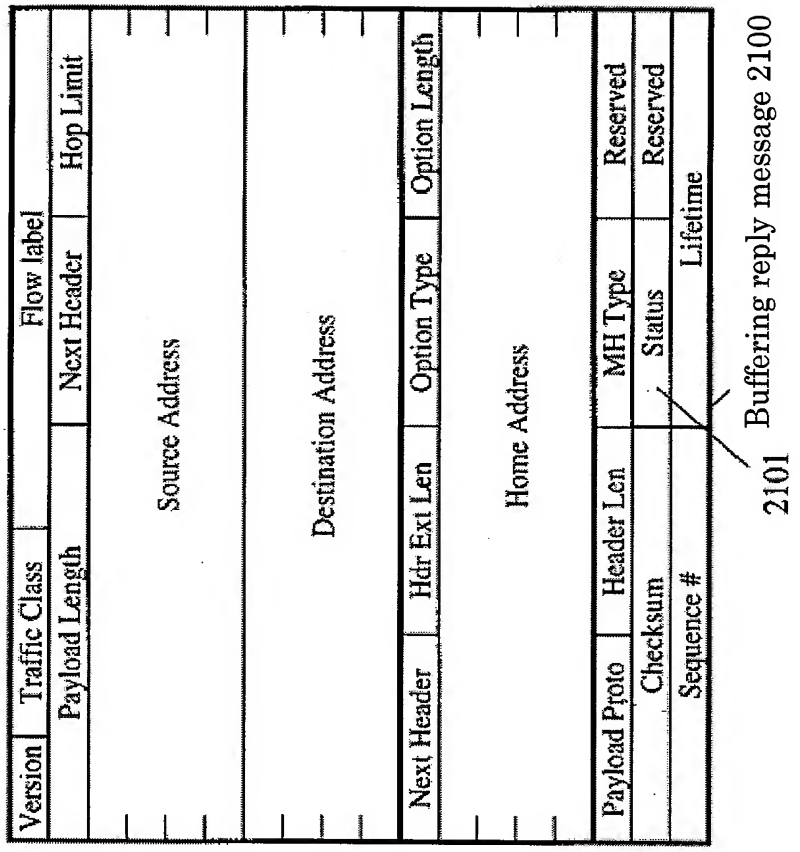
[Fig. 23]


Version
Traffic Class
Flow label
Payload Length
Next Header
Hop Limit
Source Address
Destination Address
Payload Proto
Header Len
MH Type
Reserved
Checksum
Status
K
Reserved
Sequence #
Lifetime
Fast binding acknowledgement message 1900

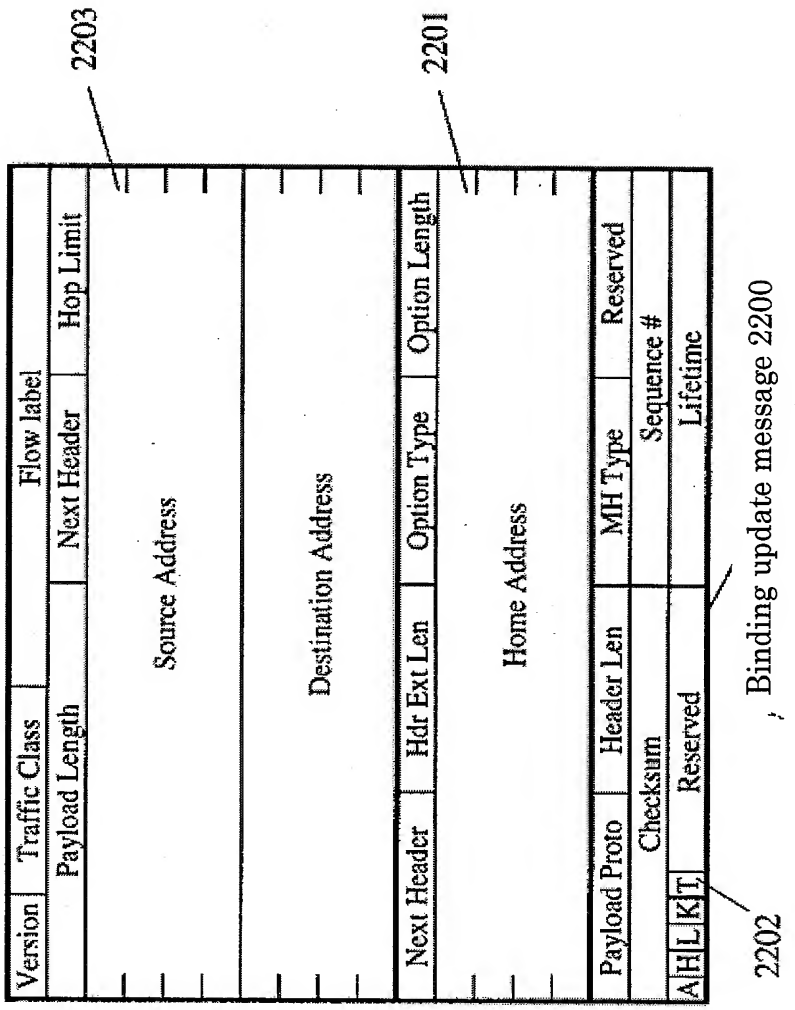
[Fig. 24]


Version
Traffic Class
Flow label
Payload Length
Next Header
Hop Limit
Source Address
Destination Address
Next Header
Hdr Ext Len
Option Type
Option Length
Home Address
Payload Proto
Header Len
MH Type
Reserved
Checksum
Sequence #
B
Reserved
Lifetime
2002
2001
Buffering request message 2000

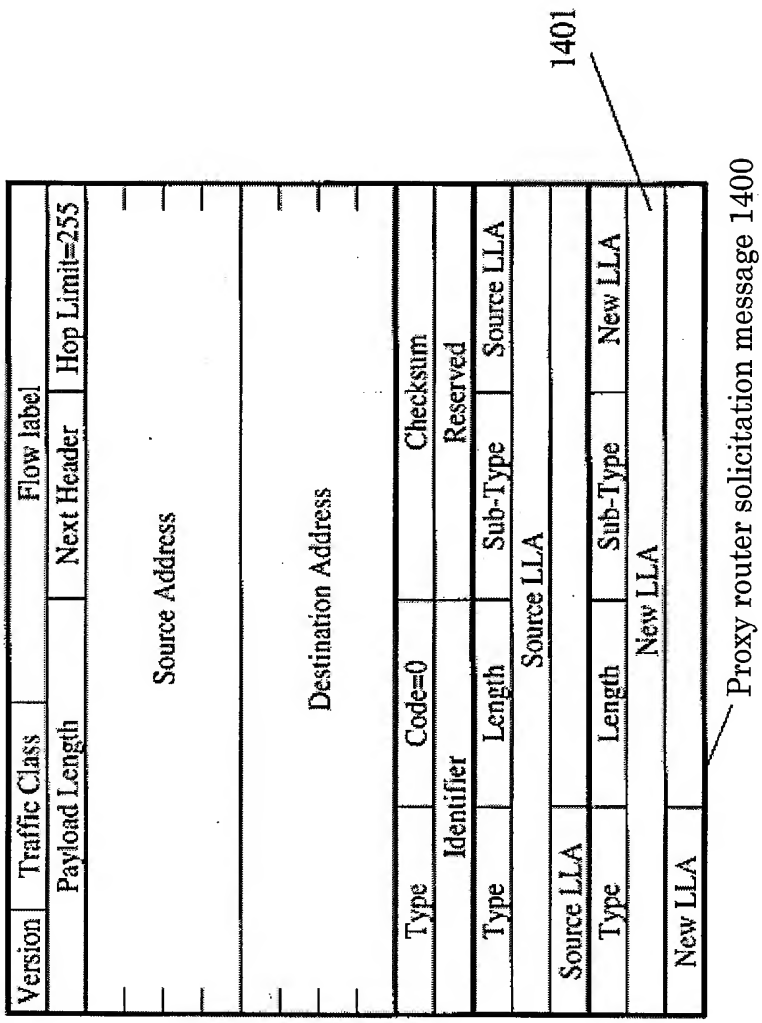
[Fig. 25]


Version
Traffic Class
Flow label
Payload Length
Next Header
Hop Limit
Source Address
Destination Address
Next Header
Hdr Ext Len
Option Type
Option Length
Home Address
Payload Proto
Header Len
MH Type
Reserved
Checksum
Status
Reserved
Sequence #
Lifetime
2101
Buffering reply message 2100

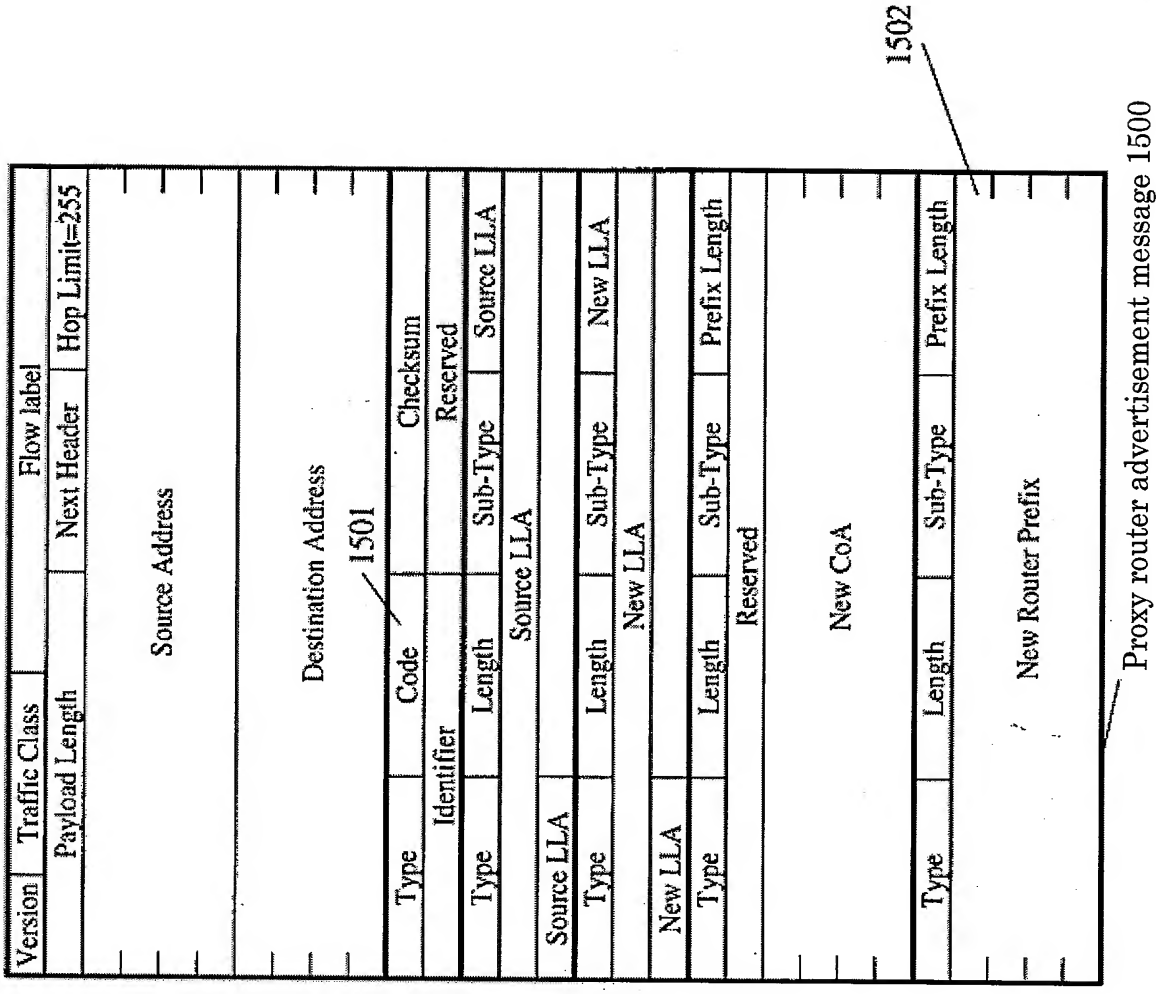
[Fig. 26]


Version
Traffic Class
Flow label
Payload Length
Next Header
Hop Limit
Source Address
Destination Address
Next Header
Hdr Ext Len
Option Type
Option Length
Home Address
Payload Proto
Header Len
MH Type
Reserved
Checksum
Sequence #
A
H
L
K
T
Reserved
Lifetime
2203
2201
2202
Binding update message 2200

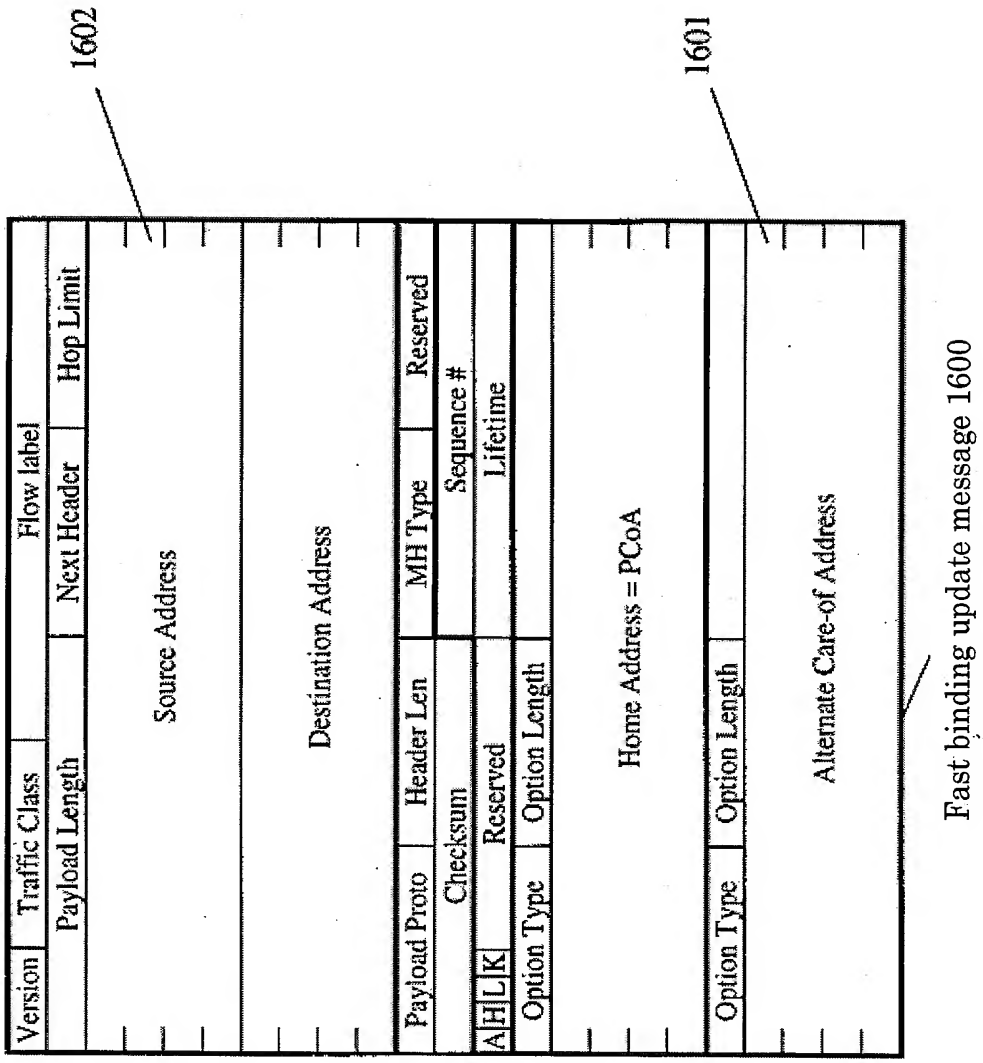
[Fig. 27]


Version
Traffic Class
Flow label
Payload Length
Next Header
Hop Limit=255
Source Address
Destination Address
Type
Code=0
Checksum
Identifier
Reserved
Type
Length
Sub-Type
Source LLA
Source LLA
Source LLA
Type
Length
Sub-Type
New LLA
New LLA
New LLA
1401
Proxy router solicitation message 1400

[Fig. 28]


Version
Traffic Class
Flow label
Payload Length
Next Header
Hop Limit=255
Source Address
Destination Address
1501
Type
Code
Checksum
Identifier
Reserved
Type
Length
Sub-Type
Source LLA
Source LLA
Type
Length
Sub-Type
New LLA
New LLA
Type
Length
Sub-Type
Prefix Length
Reserved
New CoA
1502
Type
Length
Sub-Type
Prefix Length
New Router Prefix
Proxy router advertisement message 1500

[Fig. 29]


1602
1601
Version
Traffic Class
Flow label
Payload Length
Next Header
Hop Limit
Source Address
Destination Address
Payload Proto
Header Len
MH Type
Reserved
Checksum
Sequence #
A H L K
Reserved
Lifetime
Option Type
Option Length
Home Address = PCoA
Option Type
Option Length
Alternate Care-of Address
Fast binding update message 1600

[Fig. 30]

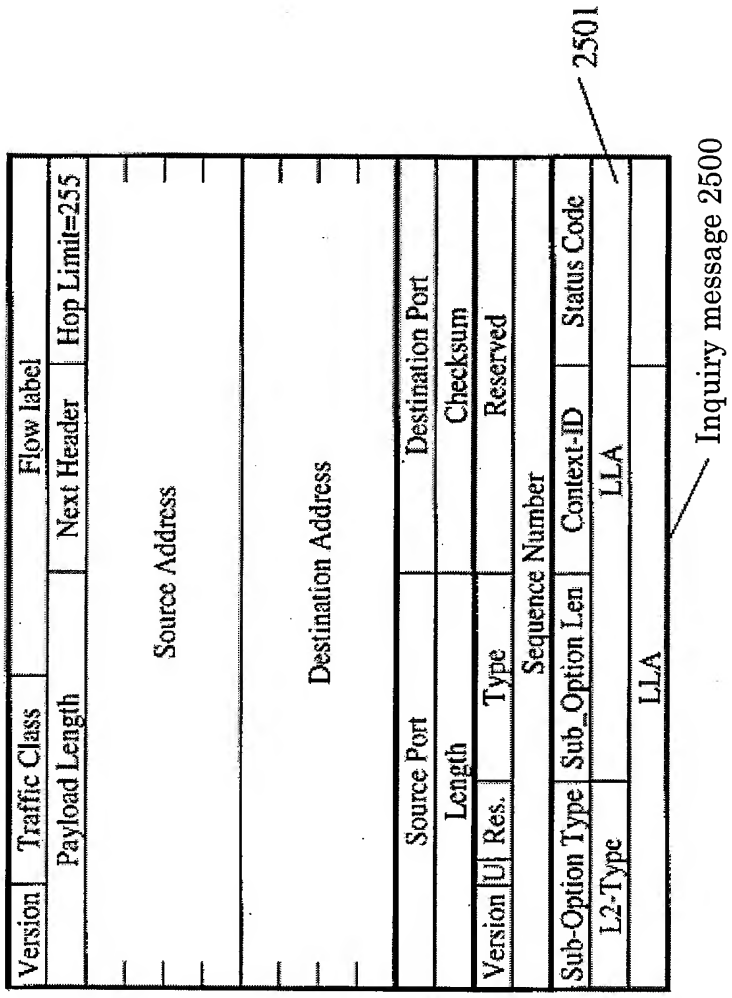
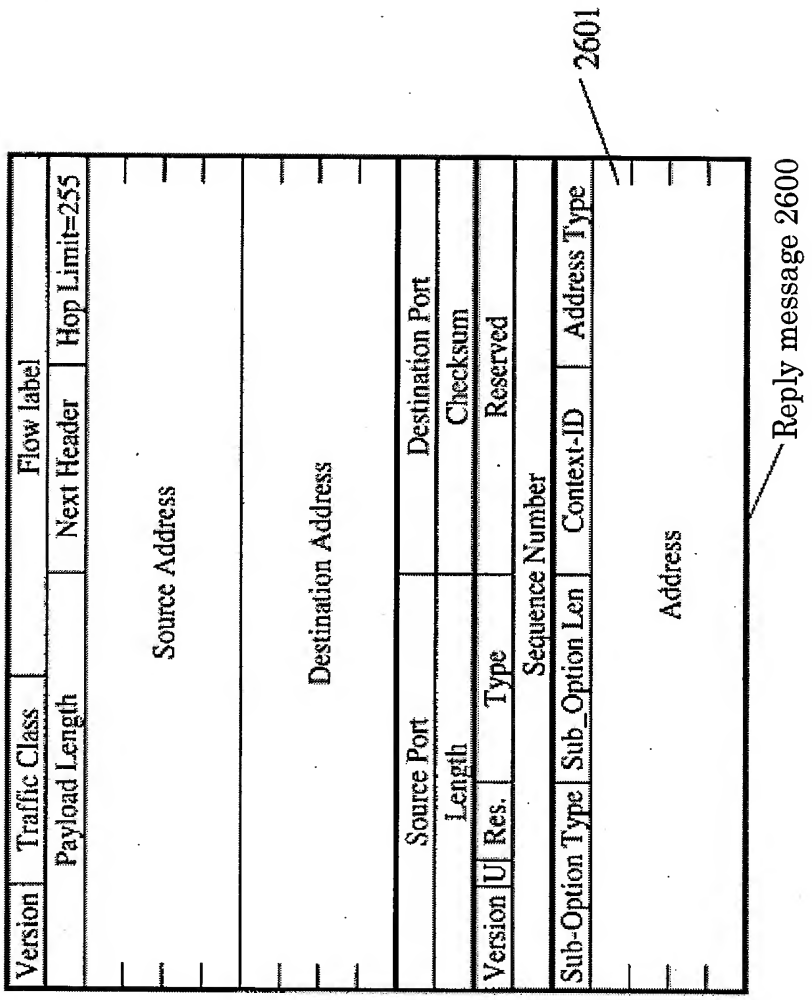
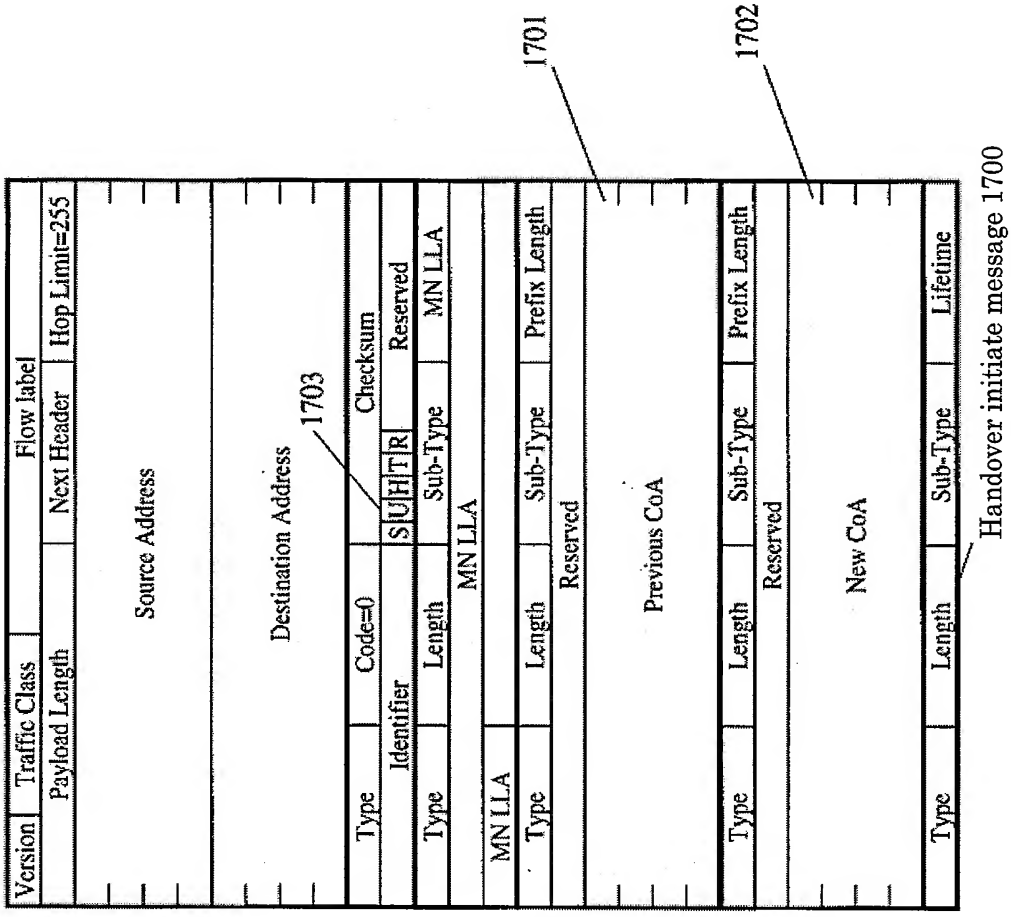

Version
Traffic Class
Flow label
Payload Length
Next Header
Hop Limit=255
Source Address
Destination Address
Source Port
Destination Port
Length
Checksum
Version
U
Res.
Type
Reserved
Sequence Number
Sub-Option Type
Sub_Option Len
Context-ID
Status Code
L2-Type
LLA
LLA
2501
Inquiry message 2500

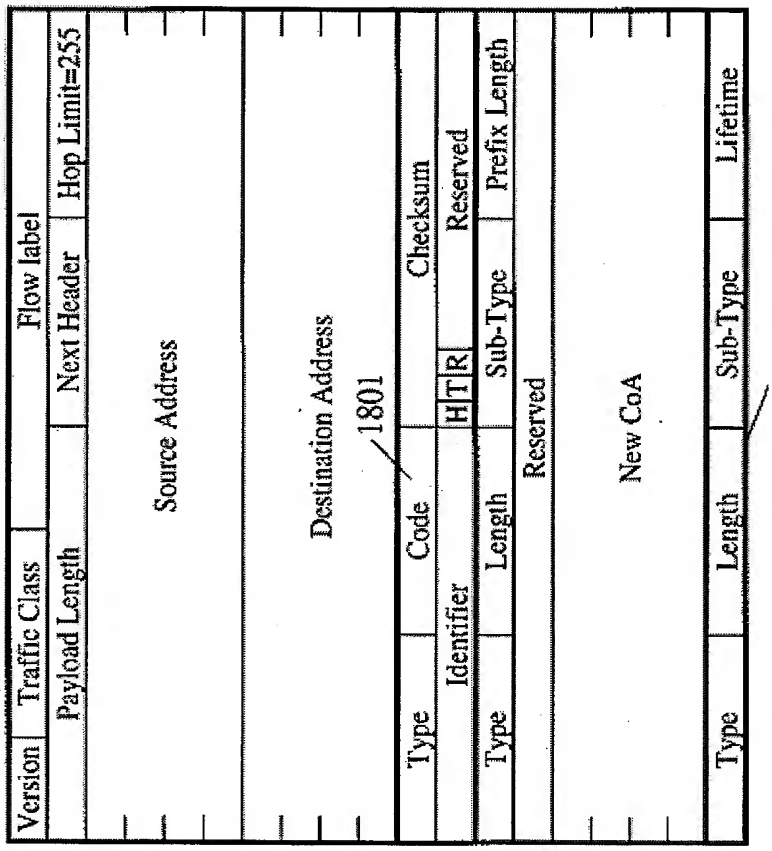
Fig. 31


Version
Traffic Class
Flow label
Payload Length
Next Header
Hop Limit=255
Source Address
Destination Address
Source Port
Destination Port
Length
Checksum
Version
U
Res.
Type
Reserved
Sequence Number
Sub-Option Type
Sub_Option Len
Context-ID
Address Type
Address
2601
Reply message 2600

[Fig. 32]

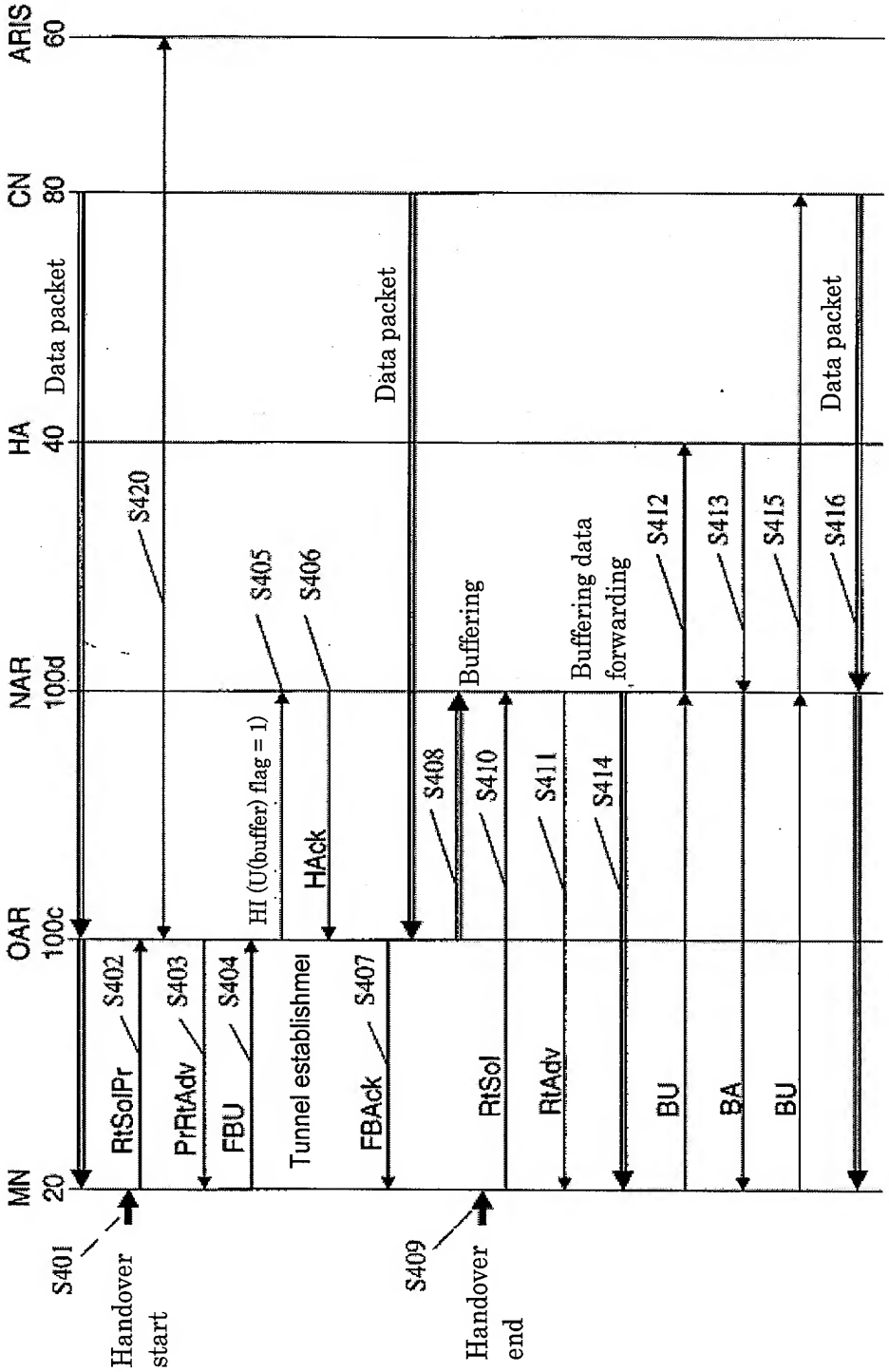

Version
Traffic Class
Flow label
Payload Length
Next Header
Hop Limit=255
Source Address
Destination Address
1703
Type
Code=0
Checksum
Identifier
S|U|H|T|R
Reserved
Type
Length
Sub-Type
MN LLA
MN LLA
MN LLA
Type
Length
Sub-Type
Prefix Length
Reserved
1701
Previous CoA
Type
Length
Sub-Type
Prefix Length
Reserved
1702
New CoA
Type
Length
Sub-Type
Lifetime
Handover initiate message 1700

[Fig. 33]



Handover acknowledgement message 1800

[Fig. 34]


MN 20
OAR 100c
NAR 100d
HA 40
CN 80
ARIS 60
Data packet
S401
Handover start
RtSolPr
S402
PrRtAdv
S403
FBU
S404
HI (U(buffer) flag = 1)
S405
HAck
S406
Tunnel establishment
FBAck
S407
S420
Data packet
S408
Buffering
S409
Handover end
RtSol
S410
RtAdv
S411
Buffering data forwarding
S414
BU
S412
BA
S413
BU
S415
Data packet
S416